COLLEGE OF ENGINEERING CORNELL UNIVERSITY

University Microfilms
313 N. First St.
Ann Arbor, Mich.

Sect.562 PL&R
U.S.Postage
PAID
Ithaca, N.Y.
Permit

the Cornell engineer

DECEMBER, 1957
VOL. 23, NO. 3
25 CENTS

Member of the Engineering College Magazines Associated

Chairman: Prof. Robert W. Bohl, University of Illinois, Urbana, Illinois
Publishers' Representatives, Littell-Murray-Barnhill, Inc., 369 Lexington Ave., New York and 605 N. Michigan Ave., Chicago

Editorial:

Complacency or Conviction?

"We are moving from a decade of technological complacency into a decade of technological decision." Thus John R. Dunning, Dean of the School of Engineering at Columbia University, summarizes the future of our nation, and indicates the impact of Russian technical progress upon every working engineer, engineering student, and engineering teacher. How can we, who have chosen the engineering profession, meet the crucial demands that face us?

How many of us as students know why we want to be engineers? What do we really want to do when we graduate? What motivates our performance in the classroom? What really concerns us as being most important? Too many of us forget that our doing the best job as students requires us to find a purpose and a meaning in our work. Too many of us are educated in spite of ourselves, rather than because of our conscious effort. And far too many of us, whether we are studying liberal arts or a specialized field, graduate without understanding what education really is. We have a good time, are collegiate, act indifferent because it is the thing to do, and leave college intellectually overconfident and spiritually undernourished.

How many practicing engineers and professors can define why they are doing what they do? How often do the routine and repetition stifle the reason and relationship of daily work? A conscious effort to do the job better today than the day before, and to show enthusiasm for doing or teaching something worthwhile can greatly influence others in their estimation of the engineering profession, and profoundly encourage young people to persist in their aspirations to be engineers.

Sputnik has challenged our attitude as well as our ability. Every engineer, and especially students and teachers, cannot escape the need to strive for more knowledge and higher quality of performance. We cannot take for granted that in missile development, nuclear power, space flight, and survival we will somehow come out on top in typical American fashion. Engineers with a true professional spirit of dedication and creativity are needed now to insure the very existence of the American heritage of freedom. Most of us have a lot of soul searching to do. Most of us have taken too much for granted, too long.

Engineering students at Cornell who are irritated about having to do a careful, thorough job, and are amused when they get a poor mark, should remember that their Russian counterparts consider it an honor to get training of equal technical quality. Education is more than taking—it is giving as well. Every engineering student must assume the responsibility to attain more than technical competence. He must broaden his vision and values through a balance of university experiences.

To be engineers qualified to meet the demands of society, students must take the initiative to read about their field beyond textbook assignments, cultivate faculty members in an effort to benefit from their personal experience, and learn something of the aspirations and creations of those who are not engineers. Engineering students must develop a professional sense of values based on a knowledge of why they are engineers and what they must do to serve others.

In an effort to relate technical skills to the world of human need, Dr. Glenn A. Olds, Director of Cornell United Religious Work, has proposed a course for engineering students. Dr. Olds desires to teach a course in the meaning of engineering and its implications in society. The course will strive to stimulate and guide engineering students in molding an effective working philosophy.

We believe there is an urgent need for Dr. Old's course, to help students formulate a meaningful perspective to culminate their five years of engineering training. We ask students, faculty and alumni to carefully evaluate their personal reaction to such a course, and to write us their comments and criticisms. The course could be offered during the fourth or fifth year as an elective.

Engineering students today must become more than technicians as they assume responsible roles of leadership tomorrow. They must know themselves, their heritage, and their potentiality. A course designed to stimulate and coordinate such knowledge will help make Cornell engineers men of value in an age of technological decision. We urge you to express your support for this worthy addition to the engineering curriculum, in the sincere belief that the course will enable students to replace complacency with conviction. R.G.B.

Founded 1885

THE CORNELL

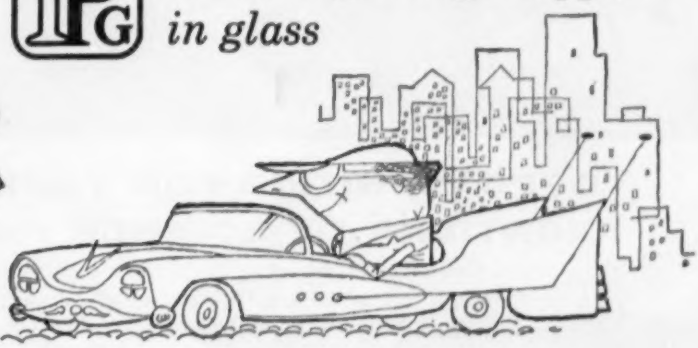
engineer

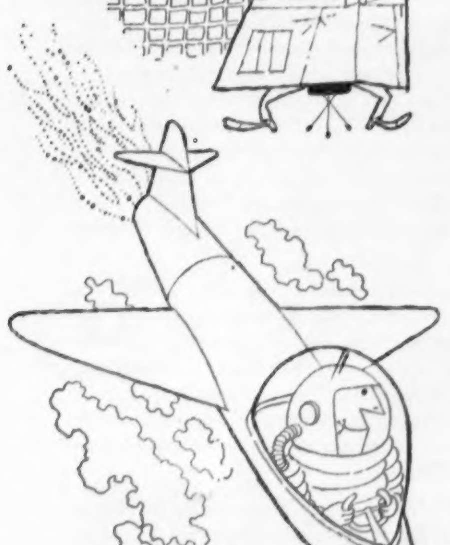
DECEMBER 1957 VOLUME 23 NO. 3

Table of Contents

Published monthly—October to May—by the CORNELL ENGINEER, Inc., Carpenter Hall, Ithaca, N. Y. Edited by the undergraduates of the College of Engineering, Cornell University. Entered as second class matter at the Post Office at Ithaca, N. Y., under Section 103, Act of October 3, 1917.

Subscription per year: regular $2.00; with membership in the Cornell Society of Engineers $3.00; student $1.50; single copy $.25.





LOOK

WHO'S

IN THE

DRIVER'S

SEAT...

...but are you

really?

and equally important,

are you going to get somewhere?

Perhaps you have heard some classmate say, almost complacently, "Times have changed."

With many branches of industry today openly competing for good science and engineering graduates, who can blame the young graduate-to-be for feeling supremely confident. You know you can get a job, know that salaries are high and are fully aware that men with technical backgrounds are moving up to administrative positions in ever-increasing numbers.

Nevertheless, in many respects, times have not changed at all. That "first job" is every bit as important today as it was five, ten, twenty years ago. Starting salaries remain only one of many factors to be considered. And a man's future is still necessarily linked to the future of the company for which he works. Moreover, a thoughtful examination of such matters as potential growth, challenge, advancement policy, facilities, degree of self-direction, permanence, benefits and the like often indicates that real opportunity *still* does not grow on trees.

For factual and detailed information about careers with the world's pioneer helicopter manufacturer, write Mr. Richard L. Auten, Personnel Department.

SIKORSKY AIRCRAFT

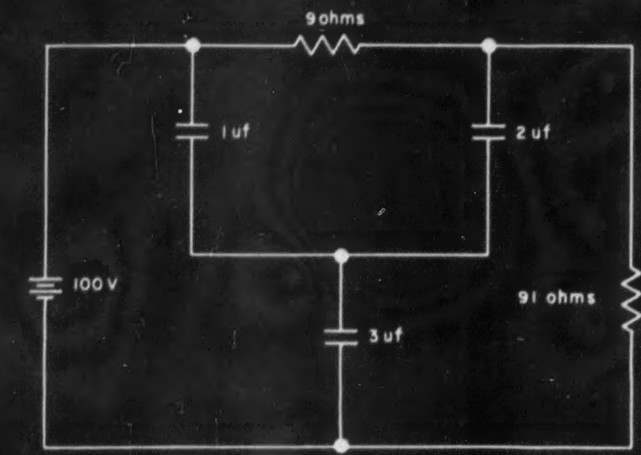
One of the Divisions of United Aircraft Corporation

BRIDGEPORT-STRATFORD, CONNECTICUT

Pittsburgh 22, Pa.

CAN YOU FIGURE IT OUT?

In the circuit shown, determine the voltage appearing across the 3 microfarad capacitor. Assume that the circuit has been operating long enough to achieve an equilibrium state.



***Solution at bottom of page**

Gerald Maley tells what it's like to be...and why he likes being...a Product Development Engineer with IBM.

FIGURING OUT A CAREER?

Selecting a career can be puzzling, too. Here's how Gerald Maley found the solution to *his* career problem—at IBM:

"What sold me on IBM," says Jerry, "was their approach to engineering. I'd expected rooms full of engineers at desks. Instead, I found all the friendly informality of my college lab." Starting as a Technical Engineer in Product Development, Jerry learned a great deal about electronic computers in a very short time. He was promoted to Associate Engineer after 16 months. Recently, he was made Project Engineer, supervising the development of magnetic cores. "In computer work," he says, "you can actually see electronics at work. This is not the case with all such equipment today. In this new field, you can be an important contributor in a very short time."

• • • •

There are many excellent opportunities for well-qualified engineers, physicists and mathematicians in IBM Research, Development and Manufacturing Engineering. Why not ask your College Placement Director when IBM will next interview on your campus? Or, for information about how your degree will fit you for an IBM career,

JUST WRITE TO:

Mr. R. A. Whitehorne
IBM Corp., Dept. 851
590 Madison Avenue
New York 22, N. Y.

IBM INTERNATIONAL BUSINESS MACHINES CORPORATION

DATA PROCESSING
ELECTRIC TYPEWRITERS
MILITARY PRODUCTS
SPECIAL ENGINEERING PRODUCTS
SUPPLIES
TIME EQUIPMENT

***SOLUTION**

The voltage across the 3 uf capacitor is 47 volts. This answer may be verified as follows:

Since the voltage across the 91 ohm resistor is 91 volts in the steady state, then

$E_1 + E_3 = 100$ or $E_1 = 100 - E_3$ (1)

and $E_2 + E_3 = 91$ or $E_2 = 91 - E_3$ (2)

let $Q_1 = I_1 T_1 = C_1 E_1$

let $Q_2 = I_2 T_2 = C_2 E_2$

then $Q_3 = I_1 T_1 + I_2 T_2$ or $C_3 E_3 = C_1 E_1 + C_2 E_2$ (3)

By substituting in equation (3) the expressions for E_1 and E_2 given in equations (1) and (2), we have:

$C_3 E_3 = C_1 (100 - E_3) + C (91 - E_3)$

Substituting all known values in this equation gives:

$(3 \times 10^{-6}) E_3 = (1 \times 10^{-6}) (100 - E_3) + (2 \times 10^{-6}) (91 - E_3)$

Dividing by 10^{-6}

$3E_3 = 100 - E_3 + 2 (91 - E_3)$

$6E_3 = 282$

$E_3 = 47$ volts <u>Answer</u>

INEERING
SCIENCE

THE FEDERAL HIGHWAY SYSTEM:

ITS PROGRESS AND EFFECTS

by

Roy J. Lamm, ChE '61

Any day now the roar of bulldozers and power shovels will announce that the fifty billion dollar Federal Highway Program is materializing in your area. This, the greatest of all building projects in history—sixty times greater than the Panama Canal—will affect more Americans than anything our nation has ever built. The program has been in operation for over a year. Basically, what are the provisions of this gigantic undertaking, how is it progressing and what will be its effects on the nation?

The Program

The program consists of the construction of a 41,000-mile Interstate Highway System, connecting 90 per cent of all cities of 50,000 or more people, forty-two of forty-eight state capitals and all forty-eight states. This system will cost 27.3 billion dollars 90 per cent of which will be financed by the Federal government and 10 per cent by the states. In addition the program greatly increases Federal aid for the improvement of the nation's Primary and Secondary Road Systems by authorizing 2.5 billion dollars for the years 1957-59 and strongly recommending that such aid should be continued after 1959 at the rate of 900 million dollars yearly until 1969. These authorizations will be matched dollar for dollar by the states, meaning that if Federal aid is continued after 1959 as is strongly anticipated, a total of 23 billion dollars will be spent in modernizing our present road systems.

The original bill signed by the President placed a thirteen-year limit on the completion of the urgently needed Interstate System. This limit, for reasons we shall see later, has had to be extended to sixteen years.

Though the Interstate System is primarily financed by the Federal government, it, like our other road systems, will be constructed and maintained by the states. Two thirds of the Federal funds will come from existing highway taxes. The other third will come from increased taxes on gasoline, diesel fuel and retread rubber, and new taxes on vehicles over 26,000 pounds gross weight.

These Federal taxes are expected to bring in a total of thirty six billion dollars over a sixteen-year period. This money will go directly into a Highway Trust Fund administered by the Treasury Department. The apportionment to any state in any fiscal year is directly related to the amount of money in the Trust Fund at that time.

The standards for the Interstate System, formulated jointly by the American Association of State Highway Officials and the U.S. Bureau of Public Roads, will incorporate all known features of safety and utility, and will provide the motorist with safe, relaxed driving. The system will provide adequate highway facilities for the traffic expected in 1975. On all but a few thousand miles of the system access will be controlled. There will

← National Highway Users Association

The interstate system, 41,000 miles of toll free super highway, is a major part of the Federal Highway Act. Highways such as the Dallas Expressway pictured here will soon stretch from coast to coast connecting 90 per cent of all cities of 50,000 or more people.

National Highway Users Association

The Federal Highway Act will have a sweeping effect on our economy. When the program is in full operation it will create 270,000 on the highway jobs, and production of highway construction equipment will have to be doubled.

National Highway Users Association

Improvement of our nation's secondary road systems gets a high priority in the Federal Highway Act. Secondary roads will be widened, straightened, and removed of such bottlenecks as the narrow, outmoded bridge shown here.

be no stoplights and no grade crossings. Sweeping curves, easy grades and long sight distances will provide maximum safety and comfort. Traffic lanes will not be less than twelve feet wide. Nearly all of the system will consist of divided highways of four or more lanes. Planning and construction will take into account natural beauty to produce scenic as well as safe travel.

These specifications will enable you to go from coast to coast without a stoplight and without paying a cent of toll. Existing toll roads, however, will in some cases be incorporated into the system, providing that the toll is lifted when the road is paid and an alternate route is available.

The Effects

Every segment of our national economy feels the impact of this fifty billion dollar undertaking. Large industries, producing the raw materials for the new roads, are in every case forced to expand production 50 to 100 per cent. Our steel mills are faced with the stupendous task of forging fifty million tons of steel for highway purposes in the next sixteen years. The annual demand for cement will increase 2⅛ times by the end of 1959. The aggregates industry has already upped production of sand, gravel and slag by 40 per cent, but this will not be enough at the program's peak when at least 560 new portable plants will be needed to meet demands. The manufacturers of highway construction equipment can see a rise in sales of 150 to 200 per cent. Explosives, paint, chemicals . . . the list is endless, touching hundreds of industries across the country.

Small businesses will also feel the effects, for by section 116 of the Highway Act, the Secretary of Commerce is advised that he should assist, insofar as feasible, small business enterprises in obtaining highway construction contracts.

In human needs 270,000 "on the highway jobs" will be created. There are no available statistics as to the number of workers that will be needed in the supporting industries forced to expand, but it can be assumed to be substantial. The benefits accruing to others not directly related to the highway industry are equally important.

The motorist, for example, will save ninety dollars a year in operating expenses when the Interstate System is completed. Experts estimate that such an adequate road system will save at least one cent a mile in travel expense. Thus a motorist who drives 9,000 miles a year saves ninety dollars. However, this isn't all profit, because the added taxes on gas and tires to pay for the roads will amount to seven dollars yearly. A simple subtraction shows a net gain of eighty-three dollars per average motorist per year.

But this leaves out other important factors. For example, the modern, safe standards incorporated into the Interstate System are expected to save 3,500 lives yearly and substantially reduce injuries and property damage due to auto accidents. When this occurs it is reasonable to assume that auto insurance premiums will be reduced. If the reduction is a modest seven dollars the cost to the motorist of the Highway Program is nullified.

The added cost of one cent per mile of inadequate roads costs the nation's motorists 5.3 billion dollars yearly. In addition there is the cost to the whole nation of high trucking rates due to traffic congestion. Because nearly everything we produce travels at one time or another by truck a slight savings per mile in shipping rates amounts to an enormous economic gain for the nation.

It is impossible to put a figure on the savings in highway deaths and injuries. If one life is saved the whole program was a success. The skyrocketing slaughter on our nation's roads has to be checked. Good roads will certainly help.

Another factor is time. What is your time worth when you're driving to and from work? If the new roads, particularly through urban areas, will reduce your time by one half what will it be worth to you in money? If it means anything you can add that to the column of economic gains, and if you estimate your time saved at seven dollars a year, you have regained your share in the road program.

National Highway Users Association

The urban system will relieve the nation's cities of their acute traffic problem. Freeways similar to this one in Los Angeles will cut urban motoring time in half.

An amazing side effect, often overlooked, is the business that will be attracted to the new highways. Development along the already built New York State Thruway, new Route 128 serving Boston, or Houston's Gulf Freeway tell an inspiring story of economic growth and improved opportunities. They mirror a nationwide panorama of business, industrial and social progress as the Interstate System is built.

As an example in four years the property value adjoining the New York State Thruway soared from 714 to 6,000 dollars per acre. This land has turned from raw farm land

to choice industrial property. Thruway authorities say the road has attracted 150 million dollars of new or expanded industries, having an annual payroll of more than 100 million dollars.

Bertram Tallamy, former chairman of the Thruway and now Federal Highway Administrator, the man in charge of the whole program, sums it up by saying:

"The tremendous toll that outmoded highways exact in lives, property damage, human misery and sheer economic waste alone compensates for the cost of constructing modern highways against many factors, but paramount among them is the economic growth and development that have become synonymous with new expressways and major highways construction programs."

The Progress

When the Romans built their 50,000 miles of roads, a marvel of the ancient world, they used a timetable of 500 years. Our Congress had planned to build the nation's 41,000 mile Interstate System on a much shorter schedule of thirteen years when they wrote the Highway Act. Already this figure has had to be adjusted to sixteen years, for after a year of operation many problems have arisen to hinder a fast start in the program and others are expected to come up which will extend the completion date from 1969 to 1972.

The unpreparedness of many states to undertake such a gigantic task has already become apparent. Several states have not even obligated all of their 1957 allotment of Interstate funds and still have no plans whatsoever for their 1958 allotment. In contrast other states who had plans and specifications on the shelf waiting for the Highway Act's passage merely pulled them down, made a few revisions and let the contracts for their full yearly allotment.

Normally it takes 20 months to locate a highway, acquire rights of way, do surveying, propose plans and specifications and finally let contracts. Thus the unprepared states will not get into high gear until the middle of 1958.

Many states do not have proper laws governing the acquisition of property, the authorization of badly needed pay increases for highway engineers, or immediate possession of property after condemnation. Others must pass new laws increasing appropriations for highways to match the Federal grants and overhaul antiquated, burdensome highway legislation.

The problem—universal among state highway departments—is the acute engineering shortage. From 5,000 to 6,000 new engineering personnel are needed for the Interstate program alone across the country. To meet this shortage highway departments are employing consulting firms. This move, however, has ironically made matters worse, because consulting firms, also looking for good engineering talent, have raided highway department's engineering staffs. In retaliation the highway departments have begun including "no raiding clauses" in their contracts with consulting firms, not without much complaint from the firms.

Twenty highway departments have met this shortage by installing electronic computers which are saving up to 50 per cent of a highway engineer's valuable time. Minor delays still result from this approach to the problem until mathematicians and engineers work out new programs to solve the many, varied highway problems. When this is accomplished, bridge designs, earth moving estimates, interchange analysis, and many more problems will be solved electronically.

Today highway departments are big business operations. Many departments, unfortunately, are still operating with 1920 techniques. They must adopt modern business methods, review organization, eliminate deadwood, and delegate authority.

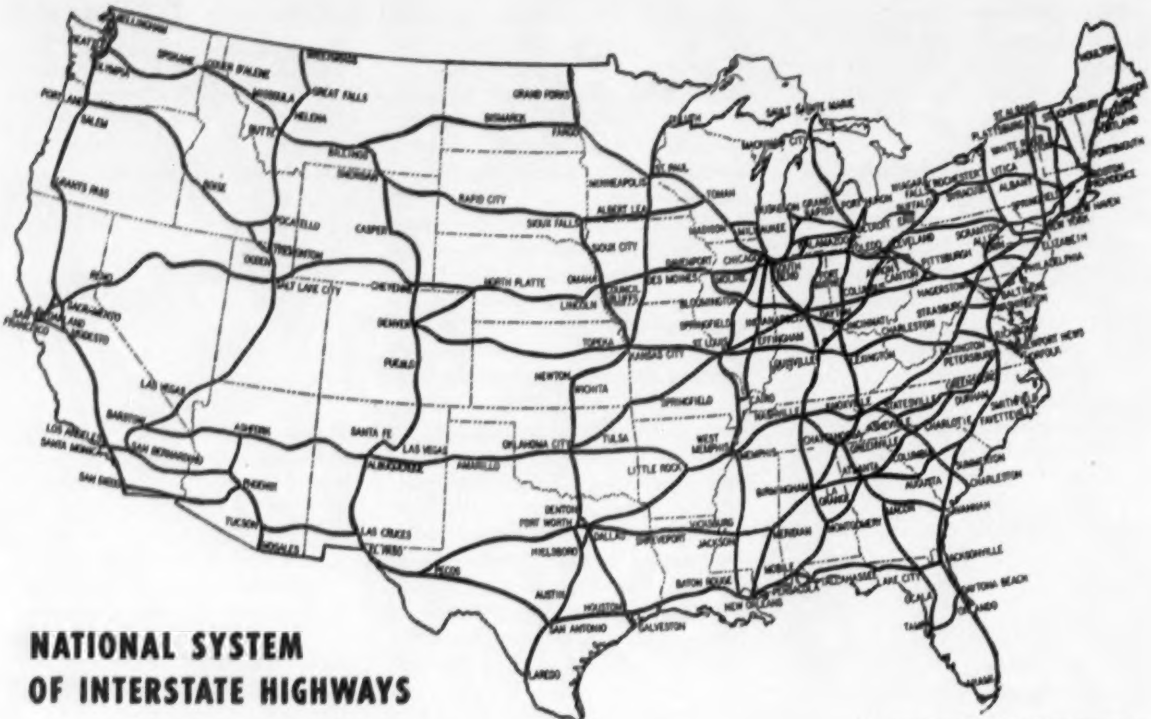
These short range problems are being ironed out daily so that soon every state will be able to undertake its share of the program on schedule.

The same cannot be said for the Federal government which faces the more serious, long range problem of financing its 24.8 billion dollar share of the Interstate program and 11 billion interest in the Secondary and Urban Systems.

Although Title I of the Highway Act authorized apportionments for the Interstate System in an efficient manner, starting with one billion in 1957 building up to 2 2 billion in 1960 and continuing at this rate until the program tapers off in 1969, Title II contains the Byrd Amendment which limits apportionments in any fiscal year to the amount of cash estimated to be in the Trust Fund. It is further stipulated that the Secretary of Treasury shall from time to time advise the Secretary of Commerce on the amount of funds available. In turn the Secretary of Commerce will have to de-

Divided highways, controlled access and a lack of grade crossings are features of the interstate system. Highways as the one pictured here will save up to 3500 lives yearly on our nation's roads.

National Highway Users Association



NATIONAL SYSTEM OF INTERSTATE HIGHWAYS

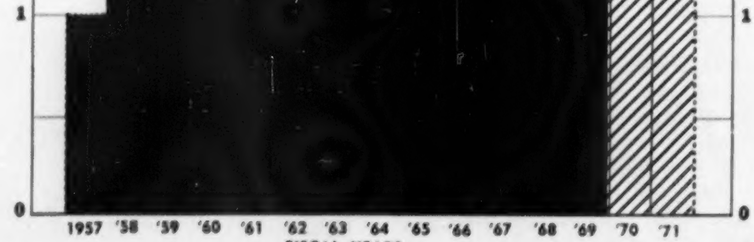
American Road Builders Association

termine the per cent of deficiency and apply an across the board cut in the state's apportionments. In other words the program is going to be "pay as you go" with no going in the "red" whatsoever.

Another section of the Highway Act stipulates that it shall be the duty of the Secretary of Commerce to report to Congress yearly on the financial condition of the Highway Trust Fund. The first such report was a minor bombshell in Congress, stating that it would take sixteen years to accumulate enough money to pay for the cost of the program. This was based upon the assumption that the Federal support of the Primary, Secondary and Urban Systems would be maintained at 900 million dollars per year with priority to these expenditures before money is let for the Interstate System. The report further indicated that instead of the orderly build up of the volume of Interstate apportionments as earlier discussed apportionments would reach 2 billion in 1959, fall off to 1.4 billion in 1961 gradually build up to 1.7 billion in 1967, and finally finish with a flourish of 2.2 billion in 1971.

With such a schedule equipment, materials and labor will be difficult to plan for, and actual construction will in many cases be slowed. However, through the entire program it is the intention of Congress to insist upon, as nearly as possible, uniform progress in all states so that a truly Interstate System results from border to border and coast to coast.

It's thrilling to look forward at the future of the United States in the next twenty years. With increasing population, climbing national income, rising level of education, scientific advances and improved health our nation is headed for an even higher standard of living. Better transportation as embodied in the Interstate, Secondary and Urban Highway Systems will spread this coming bonanza of national economic well-being to every village, town and city.



American Road Builders Association

Estimated schedule of interstate apportionments—the relationship of Congressional authorizations to actual apportionments of federal funds to the states for the Interstate program.

Some Random Impressions of Scottish Skilled Labor

by

Albert M. Sacerdote, ChemE '58

The relatively inexpensive labor found in Scotland has prompted the farming out—to Scottish factories—of fairly large numbers of jobs intended for North American consumption. Many components of at least one bridge which is to be built in Ontario are being produced in Scotland and shipped to the Canadian bridge builders. The reputation of British precision engineering and the advantages of dealing with English-speaking personnel have spurred the exportation of some manufacturing jobs. The disadvantages caused by the fairly low productivity of many Scottish workers are offset by allowing many workers from the large Scottish labor pool to work on a given project.

Work Habits

Slow work is a well-established Scottish tradition. The workers work all the time, taking only a reasonable number of breaks; nonetheless, many workers do not accomplish as much as they might. Recently, a government official asked for greater productivity to help eliminate Britain's import-export unbalance. The workers generally assumed that this was a call for more overtime and did not consider that it might be a call for more work per man hour.

Overtime is an essential part of Scottish workers' lives. Only overtime raises their meagre wage to a decent sum. The unions sometimes demand more overtime rather than increased hourly wages. Much to the disgust of ex-continentals who want to get their work over with, Scottish laborers tend to procrastinate so as to have some work for Sunday.

The exchange of higher productivity for a higher wage and, therefore, a higher standard of living may be a partial answer to Britain's financial problems. Unfortunately, the tradition of slow work is difficult to break.

The Apprenticeship System

The backbone of Scottish industry is the tradesmen, i.e. skilled workers. The tradesmen generally take pride in the specific tasks which they are called on to do. They are proud of the fact that uninteresting, repetitive jobs are normally assigned to unskilled or semiskilled men. Above all, the tradesmen are proud of being tradesmen.

The greatest advantage of being a skilled worker lies in the prestige attached to that position. Boilermakers (platers), fitters, and machine men earn only slightly more than unskilled laborers (Some trades, such as welder, pay a premium wage because occupational hazzards might otherwise discourage interest in the trade.). The difficulty of becoming a tradesman and, therefore, the prestige attached to being a tradesman stem from the apprenticeship system.

A man must, to become a tradesman, serve a five-year apprenticeship. During the first three years, he is not paid a living wage. A single man can exist on a fourth-year apprentice's wages and can live on the pay of a fifth-year apprentice.

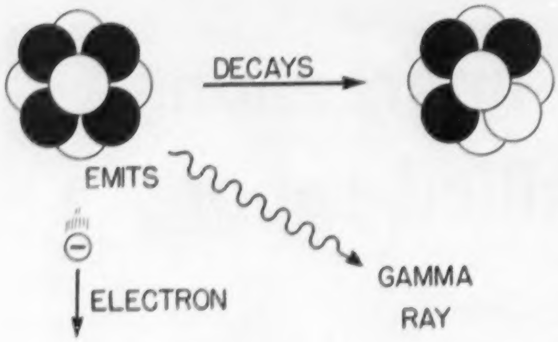
The number of people who may become apprentices is not limited. Manufacturers are often glad to hire apprentices since a fourth- or fifth-year apprentice is almost as useful as a tradesman and is paid much less. Practically, however, not all families can afford to support their sons for four years. Furthermore, a boy who contemplates an apprenticeship often disregards any future prestige and considers the choice of beginning to earn a man's pay now or in five years.

A Scotsman may quit school when he is fifteen and he may begin an apprenticeship when he is sixteen. A boy often works as an office boy, etc., during his sixteenth year. He then decides which trade, if any, to enter. After the boy becomes a tradesman, he may continue to work as long as his employer believes that he can still do his work. When old age forces a retirement, the ex-tradesman must live on the national, union, and company pensions to which he is entitled.

Financial Habits

The Scottish tradesmen's financial habits are not those normally ascribed to him. It is a rare visitor who manages to leave a Scottish home without being fed. A Scottish laborer does not offer a cigarette.

(Continued on Page 80)



KEEPING COUNT OF RADIOACTIVE PARTICLES

by
Stephen H. Saperstone, EE '61

The rapid growth of nuclear power has created an urgent need for accurate detection and measurement of radioactivity. The air around atomic reactors must be carefully controlled against deadly radiation. Also not to be overlooked are the requirements for radiation detection in nuclear bomb sites, in ore prospecting, in medicine, and in general radiological experimentation and research.

The Detector

The first phase in any radiation finding instrument is the detector stage. Here the random pulses of the bombarding radioactive particles are converted into electrical impulses. Today there a few such detectors in common use, the most popular being the Geiger-Mueller tube.

A typical Geiger-Mueller tube is a glass or metallic thin walled structure on whose inside is a cylindrical metal cathode. A thin wire that traverses the axis serves as an anode. The tube is filled with a gas under reduced pressure.

The tube operates on the principle that radiation will ionize the gas in the tube, and the ions thus formed will be attracted to the two charged electrodes. The electrodes are given a potential in the region between 400 and 1500 volts. A certain minimum voltage is necessary in order to prevent the ions from recombining before they reach the electrodes. With the correct voltage all of the ions will collect at the electrodes, thereby producing an electric current directly proportional to the amount of ionization in the tube. Some instruments are designed on this principle and measure the amount of ionization produced directly as an indication of the strength of the radioactivity.

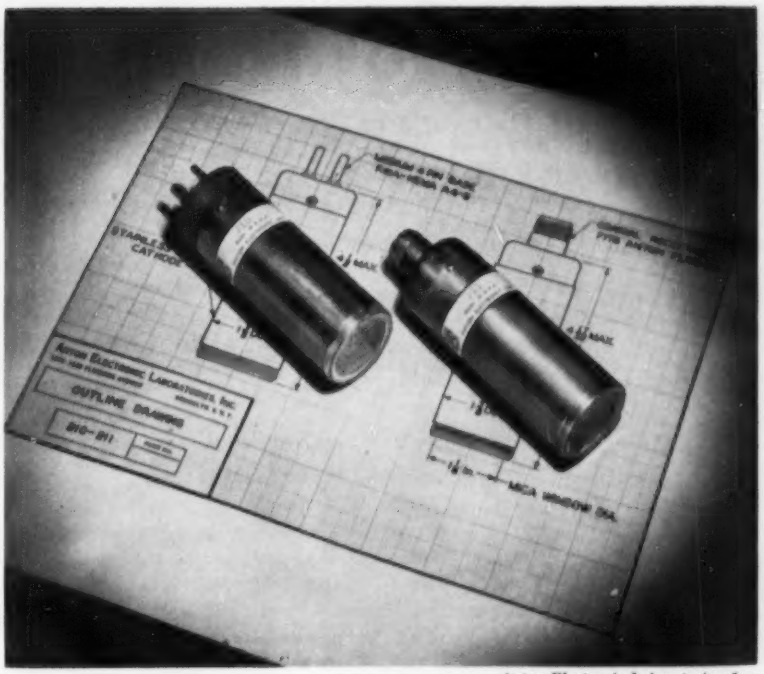
By increasing the voltage across the electrodes the ions are attracted to them with a greater force. In this process the ions attain such a velocity that they ionize other atoms in their path, and so the total amount of ionization and likewise current is increased. At such a potential the ions are accelerated to the electrodes with a speed fast enough to produce a pulse of current for each ionizing particle. Thus, with a voltage large enough to produce this ion multiplication, the resulting pulses would be directly proportional to the amount of ionization and, consequently, to the intensity of the radiation. Proportional counters, designed on this principle, can differentiate among particles of more or less energy and count particles of a specific energy falling within a wide energy range of particles. Thus alpha particles would cause large pluses and beta particles small ones.

With a further increase of potential in the tube the formation of just a single pair of ions between the electrodes can produce a whole avalanche of ions and give a relatively large pulse of current. Each particle then produces large pulses of the same magnitude. The Geiger-Mueller tube is based on this principle, for it counts every ionizing particle that enters the volume between the electrodes regardless of its energy or specific ionization.

Under proper conditions every ionized particle in the tube will be counted. For example a G-M tube is bombarded by particles of varying energies, and the potential applied to the electrodes is varied between zero and fifteen hundred volts. Up to a few hundred volts may be applied without any noticeable effect, for the avalanche effect is not great enough to produce pulses that are large enough to be counted. Further increase in voltage, though, will produce a few counts per minute. This voltage where the pulses are first detected is the "starting potential" for the counter. These counts are produced by the more highly charged particles. A further increase in potential increases the count rate, since particles with less specific ioniza-

tion are being counted. If the voltage should be increased another few hundred volts, little or no increase in count rate can be noticed. This range of a few hundred volts in known as the "G-M range" where all particles are counted. If the applied potential of the tube is plotted against its count rate, a curve such as that shown in Figure one results. The flat part of the curve corresponds to the operating range of the tube, more commonly known as its "plateau."

Proper operation of a G-M tube demands that its applied voltage be within the plateau region of its curve, preferably at the lower end of the plateau, since excessively high voltage tends to shorten the life of the tube and causes spurious discharges and consequently meaningless counts. The voltage that represents the beginning of the plateau is the "threshold voltage." The threshold voltage and plateau range depend upon the type, nature, and pressure of the gas in the tube. Most tubes have plateaus that extend over a range of two to three hundred volts in the region from about 800 to 1500 volts.



Anton Electronic Laboratories, Inc.

End Mica Window, Alpha, Beta, and Gamma Radiation Counter Tubes

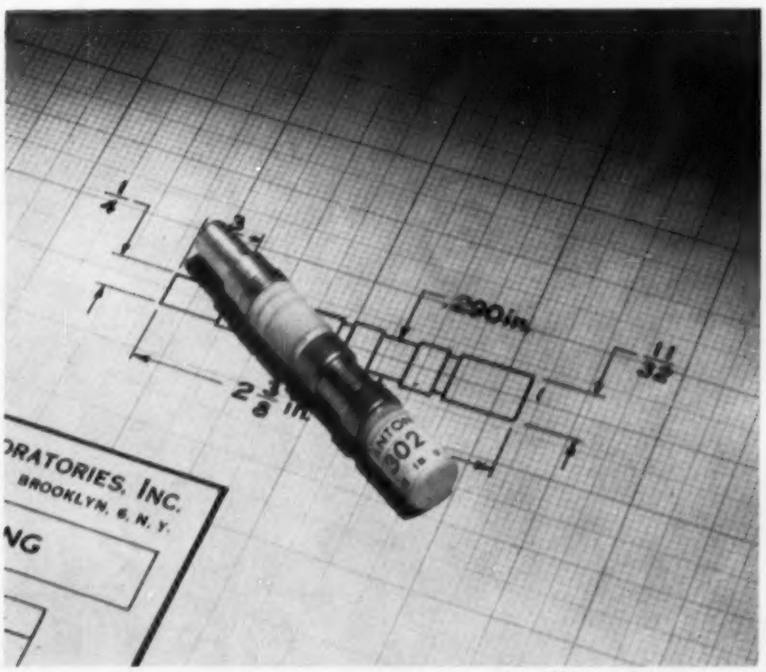
Differentiation of Particles

Up to this point no mention has been made of the ability of G-M counters to differentiate among the various kinds of radioactive particles it detects. Alpha particles, because of their large size and low energy, are not readily counted by G-M tubes. They are absorbed by the walls of the tube. There are, though, specially designed tubes with extremely thin mica "windows" which readily admit alpha particles.

The construction of most G-M tubes enables them to count each and every beta particle that enters the tube. The tube is thin walled to allow for passage of such particles.

Gamma rays, on the other hand, will penetrate nearly all types of G-M tubes. Only a small amount of the radiation penetrates the tube, but it is enough to ionize the enclosed gas. The greatest amount of ionization that takes place, though, is due to the gamma rays striking the atoms in the walls of the tube. Some of the electrons thus formed traverse the volume of the tube and produce a count. Of course, the vast majority of the gamma rays will penetrate both the gas and the tube walls without producing any effect at all. To distinguish between beta and gamma rays, a separation must be made outside the tube. This is accomplished by equipping the tube with a moveable metal shield that will absorb beta particles. Measurements are then made with and without the shield. The shielded measurement is the gamma measurement. The difference between the two is the beta measurement.

With the proper selection of tubes, alpha, beta, and gamma



Anton Electronic Laboratories, Inc.

Miniaturized Radiation Counter Tube

radiation can be detected and discerned. Actually there are other methods of identification other than utilization of special type G-M tubes. The subsequent electronic circuits that follow the G-M tube can measure the pulse height of the signal and thus determine the nature of the particle, since all three particles are of different energy levels and produce different strength pulses.

Time Intervals

The time involved for a G-M tube to make each count must be taken into consideration when relatively large count rates are detected. If a particle enters a tube before the discharge of a previous avalanche is cleared up, the pulse produced by the particle will be confused with the preceding one and likewise for subsequent pulses. As a result an incorrect low count is obtained. The avalanche must be halted then and the tube cleared of ions to produce an accurate count. This is accomplished by "quenching." Space charges that accumulate around the electrodes affect some degree of quenching. By far the best quenching method utilized today is to fill the tube with a certain material that will absorb excess energy from the gas atoms. Organic gases and vapors such as methanol and ethyl alcohol are generally used. The main drawback of organic quenchers is that they are decomposed in the process, in part by the high voltage. Halogen quenchers alleviate this problem, for they recover and last longer.

Approximately one five-thousandth of a second is required for

Anton Electronic Laboratories, Inc.

Ruggedized, high-sensitivity radiation counter tube with end mica window, especially designed to provide quantitative measurement of radioactivity for such purposes as medical diagnosis and tracer work.

a G-M tube to deliver a pulse and recover its stability. If two or more particles enter the tube within this period, still only one pulse will be delivered. Precision work, therefore, demands that a "coincidence" correction be applied to compensate for these false counts. Accurate counts can be made up only to a few thousand per second since radiations are emitted more in a random nature than in uniform fashion.

Photomultiplier Tube

Another important device used in the detector stage is the photomultiplier tube. Radiation strikes a scintillating crystal which in turn emits a faint pulse of light for each ray. The photomultiplier tube is a light sensitive device which, when used in conjunction with a scintillating crystal, will convert light pulses in the crystal to electrical impulses at the output of the phototube.

The photomultiplier, besides having the usual cathode and anode, has nine additional anodes called "dynodes," arranged in a circular path around the cathode. The potential of the cathode and each of the dynodes is negative with respect to ground. The cathode is at a higher negative potential than the anodes.

The voltage supply for the cathode is in the neighborhood of −1100 to −1600 volts. A voltage divider network across the dynodes offers progressively lower negative potentials to each dynode around the circle. Thus, for example, with a cathode potential of −1400 volts and the first dynode at −1200, there is a drop of 60 to 90 volts to the second dynode and similar drops to each successive dynode. The potentials of the electrodes are variable to control the tube's sensitivity.

Light from the crystal detector is directed at the cathode of the photomultiplier, and consequently photo electrons are emitted. These electrons are attracted to the first dynode, since it is positive with respect to the cathode by about 150 to 200 volts. Secondary emission results at the dynode and this greater mass of electrons is then accelerated to the next dynode by the voltage drop across resistor R2. (See Figure two.) This process continues until all of the electrons reach the final collector anode. At this point the number of electrons that originally left the cathode has multiplied by a factor of nearly a million. This current charges the capacitance on the anode causing a

(Continued on Page 76)

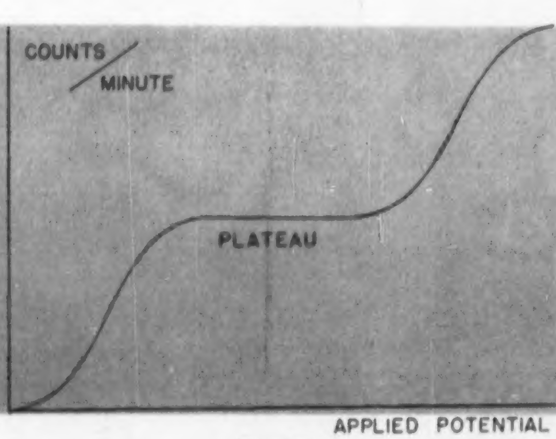
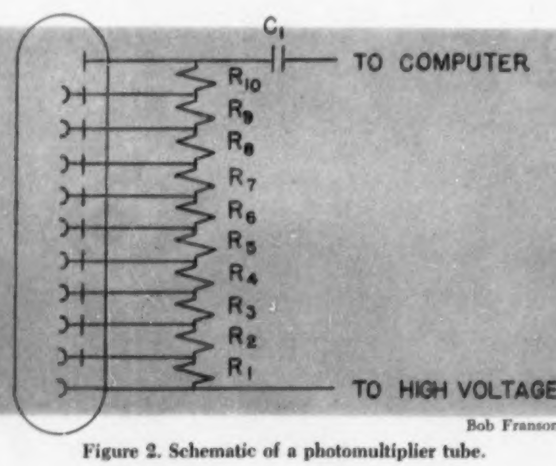


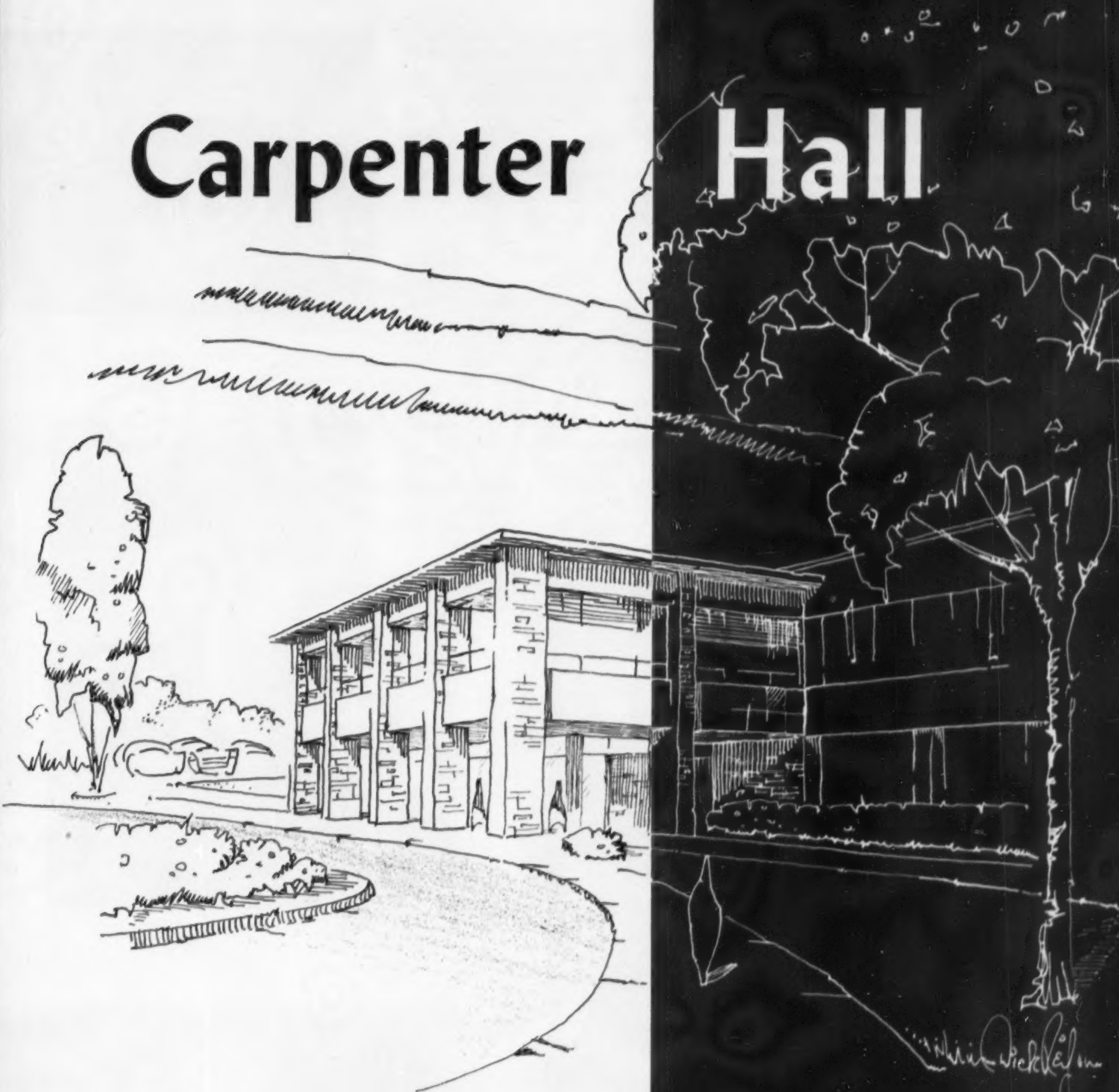
Figure 1.



Bob Franson

Figure 2. Schematic of a photomultiplier tube.

Carpenter Hall



Donation of
Walter S. Carpenter, Jr., '10

Carpenter Hall Dedicated

Walter S. Carpenter Jr. presented Carpenter Hall to Cornell University at ceremonies held in the main reading room of the new building on November 1. The dedication marked the official opening of the College of Engineering's newest facility, housing the technical library, administrative offices, Office of Student Personnel, and the office of the CORNELL ENGINEER.

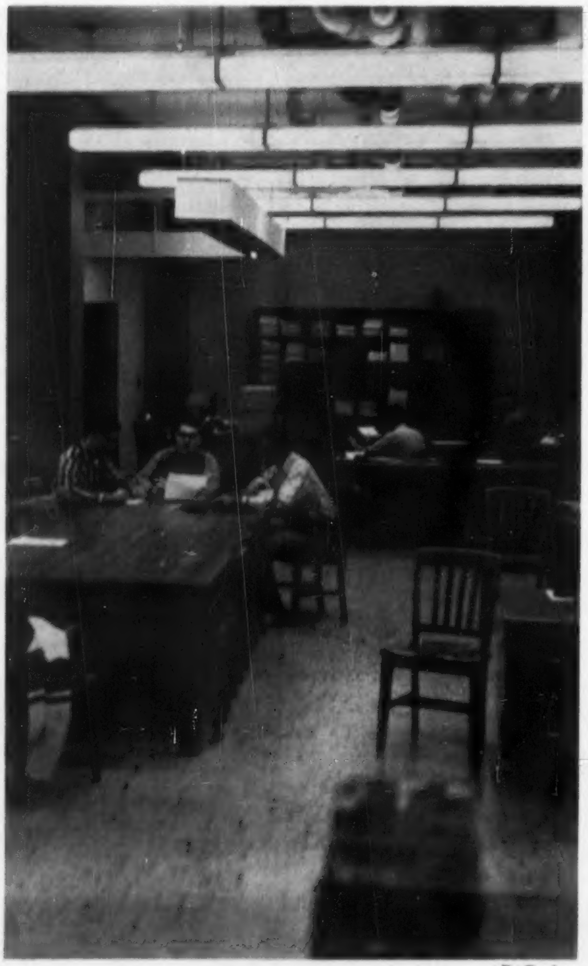
Presiding at the dedication ceremony was John Collyer, Chairman of the Board of Trustees of Cornell University. University President Deane Malott formally accepted the new building, and Dean S. C. Hollister responded for the College of Engineering.

Speaking on behalf of the student body, Scott Lewis, ME '58, president of Tau Beta Pi, stated that Carpenter Hall is at the center of the newest part of the Cornell Campus, engineering quadrangle. He asserted that the new building will enable students to pursue their academic interests by using the library facilities, their "personal" interests by contact with placement, admissions, and scholarship services and their professional interests through the administrative offices of the College of Engineering.

Guests at the dedication were the first to see the beautifully appointed Albert W. Smith browsing room adjacent to the main library reading room. The room, named for the Director and Dean of the Sibley College of Mechanical Engineering from 1904-1921, will house a collection of non-technical books designed to stimulate the cultural awareness and liberal insight of engineering students.

Dean Hollister summarized the significance of the browsing room by explaining that Dean Smith, af-

J. Frey



P. Gaalaas

The new office of the *Engineer* in the basement of Carpenter Hall

R. Epstein

fectionately called "Uncle Pete" by his students, was "interested in rounding the engineering student beyond the range of his technical competence." Dean Hollister expressed the hope that the browsing room would trigger the interest of engineers to extend their extra-curricular reading to include greater use of the Main Library.

In addition to the browsing room, Carpenter Hall library facilities include present stack space for 75,000 volumes with capacity for expansion to 200,000 volumes plus 20,000 volumes on reading room shelves. A second general reading room is located on the second floor, along with individual study rooms, for persons engaged in library projects.

As an outstanding industrialist and a great Cornellian, Walter Carpenter made possible the nerve center of the College of Engineering, Carpenter Hall. His generosity was marked by a deep humility, and a hope that the library will be a "dynamic and vigorous center of intellectual inspiration for all associated with the school."

Mr. Carpenter was president of the DuPont Company for nearly eight years before being elected Chairman of the Board in 1948. While a student at Cornell University, he worked during the summers of 1907-09 at the DuPont dynamite plant in Gibbstown, New Jersey. After his fourth year at Cornell began, he was informed of a job opportunity with DuPont in Chile. He decided to accept the position and spent two years in South America.

When Mr. Carpenter returned to the United States, in 1911, he joined the staff of the DuPont Development Department. He then progressed rapidly, to become director of the department, a member of the company's Board of Directors, and at the age of 31, vice president in charge of the Development Department. At 38 he was appointed vice president in charge of all financial matters. When he assumed the responsibility of the presidency of E. I. DuPont de Nemours in 1940, he was the first man not a member of the DuPont family to hold the position.

Mr. Carpenter has been on the Board of Trustees of Cornell University, and has made possible the new skating rink on the Cornell campus. The value of his service to Cornell was reflected in the words of University President Malott, who, speaking of Walter S. Carpenter and Carpenter Hall, said, "I hope some of his character will be transmitted to the students who will tread these halls."

R. G. Brandenburg

P. Gaalaas

P. Gaalaas

R. Epstein

Photo Science

THE SILICON SOLAR CELL

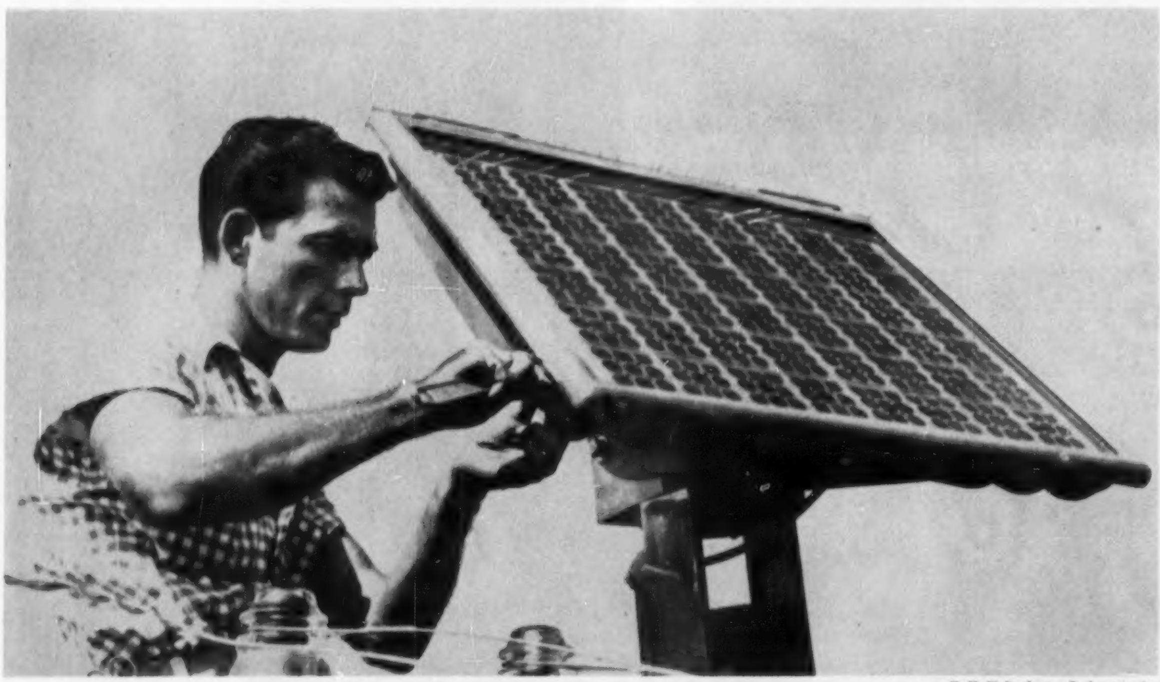
by
Donald M. Malone, EE '59

For many years men have been trying to utilize directly the large amount of energy that the sun radiates to the surface of the earth. After the Seebeck effect was discovered in 1823, the thermopile was developed, but its maximum efficiency was only one per cent—hardly enough for practical energy conversion purposes. Although other solar energy converters were developed later, the thermopile's efficiency remained highest. Then in 1954 D. M. Chapin, C. S. Fuller, and G. L. Pearson announced the development of a device that would convert solar energy into electricity with an efficiency of 6 per cent.

This device is the silicon solar cell. Since the original announcement of the cell, its efficiency has been raised to 11 per cent. To put this in more practical terms, a battery situated in Arizona and having an effective area of one square meter is capable of producing an electrical power output of 110 watts on a sunny day.

Silicon, the principal constituent of the solar cell is the second most plentiful element in nature, oxygen being first. It always occurs in a combined state and constitutes about 26 per cent of the earth's crust, oceans and atmosphere. The silicon used in the solar cell is manufactured by du Pont and is extremely pure.

The manufacture of this extremely pure silicon is a difficult process. First, silicon tetrachloride is produced. The commonest method of production consists of mixing sand and coke, then passing chlorine gas



Bell Telephone Laboratories

Hitching solar batteries to the telephone system at Americus, Georgia.

over the mixture while it is being heated in a furnace. $SiCl_4$ is formed according to the following equation:

$$SiO_2 + 2C + 2Cl_2 \xrightarrow{800^\circ\ C} SiCl_4 + 2CO$$

The resulting product is usually distilled to remove impurities. This commercially produced $SiCl_4$ is then used in the production of pure crystalline silicon.

The pure silicon is produced in a quartz reactor. Both $SiCl_4$ and zinc are vaporized, and their vapors flow into the reactor where pyrolytic reduction of the silicon tetrachloride by the zinc at a temperature of about 1740° F. produces a mass of needle-like crystals of silicon. The final purity is greater than 99.9%, the principle impurity being carbon.

Solar Energy Conversion

Before the fabrication of the solar cell is discussed, the theory behind the conversion of solar energy to electrical energy in silicon will be shown. Silicon's ability to effect this conversion depends on the presence of minute quantities of certain impurities in its crystal structure. The discussion that follows applies only to perfect and nearly perfect crystals of semi-conductors such as germanium and silicon.

Silicon has four valence electrons, and in its pure solid state, it forms a diamond crystal lattice. In this lattice, the valence electrons of a particular atom are shared covalently with electrons from its four adjoining neighbors. The covalent bond restricts the movement of the electrons, and only the fact that these bonds can be broken thermally prevents pure crystalline silicon from being an insulator. For this reason, silicon is called a semiconductor. In its pure state silicon also has no energy converting properties; however, the addition of very small amounts of certain impurities can cause these properties to appear.

Suppose that an element possessing five valence electrons (such as phosphorus, arsenic, or antimony) is carefully added in minute quantities to a crystal of silicon. If this is done, a few random positions in the silicon lattice that were formerly occupied by silicon atoms will now be occupied by atoms of the impurities. Since only four of the impurity atom's valence electrons are covalently bonded to neighboring atoms, the fifth electron is very loosely bound and at room temperature is free to roam around and conduct electricity. The impurities just described are therefore called donors, because they donate excess electrons.

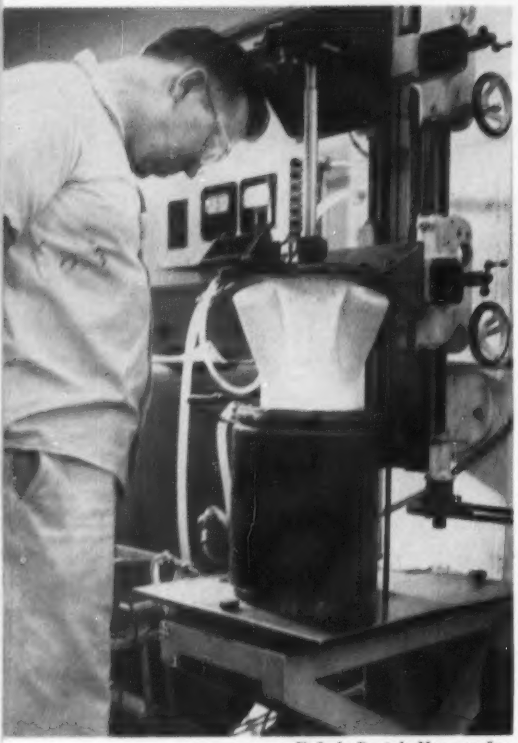
Starting again with a pure crystal of silicon, suppose this time that an element possessing only three valence electrons (such as boron, aluminum, gallium, or indium) is carefully added in minute quantities to a crystal of silicon. As before, a few scattered positions in the silicon lattice that formerly were occupied by silicon atoms will again be occupied by atoms of the impurities. In this instance, however, the impurity atom only has three valence electrons. Since the impurity atom has four neighbors, a gap or hole in which a fourth electron is needed to complete a covalent bond results because of the strong tendency for each atom in the silicon crystal to form four covalent bonds. If a nearby silicon atom contributes an electron to the

E. I. du Pont de Nemours Inc.

Above: A specimen of hyperpure silicon (held by technician). Beneath it is an induction-heated crystal growing furnace.

Below: The characteristics of a completed solar battery are carefully checked at this test station.

Bell Telephone Laboratories



E. I. du Pont de Nemours Inc.

Technician observing the growth of a crystal of hyperpure silicon in a resistance heated furnace. This process produces single silicon crystals almost 100% pure.

impurity atom, the hole (need for an electron) will reappear next to the donating silicon atom. This process does take place continuously, giving this hole (which has a positive charge) a mobility similar to the mobility of the electron in the former example. The impurities used in this type of material are called acceptors, because they accept electrons.

'Doping' and its Consequences

The process of placing a small amount of a donor or acceptor in a crystal of silicon is called doping. The donor doped silicon is called *n*-type silicon (for excess negative charges), and the acceptor doped silicon is called *p*-type silicon (for excess positive charges).

If in a pure crystal of silicon, donor atoms are added to one portion of the crystal and acceptor atoms are added to the remainder, the boundary region between the *p* and the *n* portions of the crystal is called a *p - n* junction. The *p - n* junction has very interesting properties. Surrounding the *p - n* junction is a built-in permanent electric field. This field separates the *n* and *p* regions from each other, and prevents the electrons of the *n* region from crossing over the *p - n* junction to fill up the holes of the *p* region. If for some reason, an electron in the vicinity of the *p - n* junction moves out of its normal position, thus creating what is known as a hole-electron pair, the electric field surrounding the *p - n* junction will force the hole into the *p* region and the electron into the *n* region. This process is called collecting. If collecting did not take place (perhaps the hole-electron pair occured too far away from the *p - n* junction), the electron would move back to its former position, i.e. the hole-electron pair would recombine.

As was previously stated, a built-in permanent electric field exists in the region surrounding a *p - n* junction. This fact might lead one to believe that if wires are attached to the *p* and *n* regions, and the wires are joined, a current will flow. Normally this will not occur because contact potentials between the wires and the *p* and *n* regions cancel out the potential due to the electric field at the *p - n* junction; however, under certain circumstances, this situation can be altered.

When light energy impinges upon a silicon crystal containing a *p - n* junction, hole-electron pairs are created in the region near the surface of the crystal. Those hole-electron pairs which appear in the vicinity of the *p - n* junction are collected by the electric field surrounding the *p - n* junction, and under these circumstances, if a wire is attached from the *p* to the *n* region, a current will flow through that wire. The energy of this electric current can be utilized in the same ways that the energy from any other direct current can be utilized, and this is the underlying mechanism by which solar energy is converted to electrical energy in the silicon solar cell.

Technical Difficulties

Although the principles underlying the activity of the solar cell are relatively simple, the technical problems involved in detail are still causing much difficulty. It has been shown by mathematical analysis that the theoretical maximum efficiency of a silicon solar cell is 21.7%, but this maximum has not yet been attained. There are several important design characteristics that affect the maximum attainable efficiency.

One might first ask if some other semi-conductor, perhaps germanium, would be more efficient than silicon. Germanium does have a higher short circuit current than silicon, but because of the difference in voltage characteristic, silicon has a greater power density (power output per unit area available to the sun) than has germanium. It has been shown theoretically that silicon has very nearly the best possible characteristics for conversion of solar energy to electrical energy.

A second important factor to consider is reflectivity. Covering the cells with non-reflective coatings reduces but does not eliminate loss due to reflection.

A third factor to consider is the best type of load for the cell. It has been shown that with varying degrees of sunlight energy density, peak efficiency is maintained at a constant voltage. If the voltage at the terminals of the cell changes, the cell efficiency changes markedly. This indicates that the best load for a solar cell to operate into is a storage battery (which has a practically constant terminal voltage).

Another important design factor is the series internal resistance of the cell (Rs). As this resistance increases, efficiency decreases. An internal series resistance equal to five ohms will lower the power output of the cell to thirty per cent of the value of power output obtainable when Rs equals zero. Fortunately, a value of internal shunt resistance as low as one hundred ohms will have very little effect on efficiency and a typical value for the internal shunt resistance in practice is about one thousand ohms. It can be seen that while internal shunt resistance practically presents no problem, the internal series resistance is an important design consideration.

The last important consideration is the method of attaching conductors to the cell. Originally metallic lacquers were brushed on top of copper-plated sections of the cell, but deterioration occurred with time. Since then, methods such as ovenfiring of metallic layers, metal-

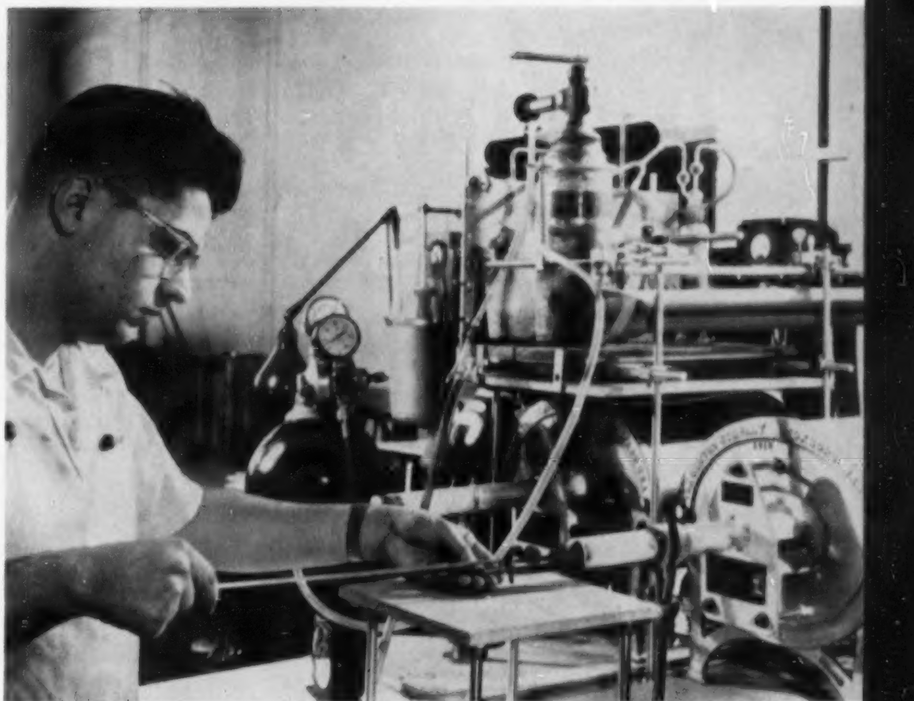
lic vapor deposition, and electroplating have been tried. One method of affixing conductors will be discussed later in detail.

Fabrication and Packaging

The extremely pure crystalline silicon previously described is melted, and a minute amount of arsenic (about one part arsenic to one million parts silicon) is added to the melt. Then a large single crystal of arsenic doped silicon is slowly pulled from the melt in such a manner that the interface between solid and liquid in the crystal is substantially at the surface of the liquid. This pulling technique results in a single crystal of excellent properties in which thermally induced strains and other undesirable effects have been minimized. The crystal is then cut into correctly sized wafers with a diamond cutting wheel.

The final and most delicate step in the preparation of a silicon cell is the diffusing of boron into the surface of the arsenic doped crystal. If the boron diffuses too deeply, the p - n junction will be too far below the surface to collect effectively. If the layer is too thin, its Rs will increase, causing an appreciable cut in efficiency. Consequently, the Bell laboratories have done much research on depth of penetration vs. time and temperature of diffusion. The diffusion process involves filling a quartz container with nitrogen gas, then inserting the arsenic doped silicon wafer along with a quantity of boron trichloride, and placing the assembly in an induction furnace for a controlled length of time and at a temperature between one thousand and twelve hundred degrees centigrade. In the diffusion process, silicon atoms form gaseous $SiCl_4$ and the released boron atoms fill the spaces in the crystal lattice that the silicon atoms vacated. After the diffusion time has elapsed, the assembly is removed from the furnace and the wafer is allowed to cool.

Next the conductors must be affixed to the p and n regions. This is one area of production that is still under research, since the present method of affixing conductors is time consuming and must be done very carefully. Sequence is also very important to the process. Care being taken to see that the p-type surface is not scratched, the wafer



Bell Telephone Laboratories

A quartz tube containing arsenic-doped silicon wafers, boron tetrachloride, and nitrogen gas is introduced into a furnace. During the heating process, the boron will diffuse into the wafer.

is boiled in nitric acid. After it has been in the nitric acid for a sufficient time, the wafer is removed, and thoroughly wiped dry with soft filter paper. The oxide left on the surface is then removed with fluoric acid. If the nitric acid was not cleared off completely beforehand, unwanted etching of the surface will occur. After the surface is cleaned by the fluoric acid, the wafer is placed in a solution containing nickel ions. Nickel is electrically deposited on the p-type silicon surface and a wire lead is easily affixed to the layer of nickel.

To attach a conductor to the n-region, a portion of the p-layer must be removed from the bottom side of the cell, (the side on which nickel was deposited). The remainder of the p-layer, which is not to be removed, must be protected by a covering of wax or teflon tape. The unprotected portion of the p-layer is removed either by sandblasting or by placing the wafer in a solution of both nitric and fluoric acid. After the p-layer is removed, the surface of the n-region is left rough, and nickel is placed on it by electro-deposition.

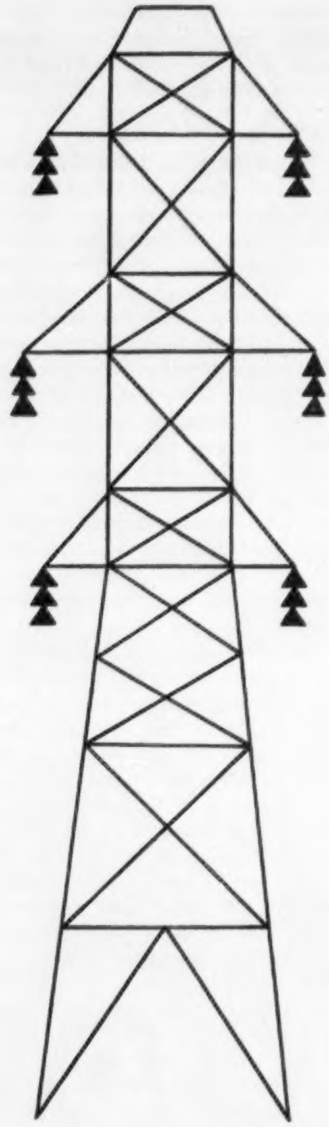
After individual solar cells are produced, nine of them connected in series are arranged three by three in a module. Each module is a separate plastic container, the cover being machined from ⅜″ acrylic sheet of plastic. The plastic over the cell area is cut down to a thickness of 1/16″. To cut down reflectivity, the region between the cell surface and the cover surface is filled with silicone oil. This is another area where research is continuing as the silicone oil seems to leak away or evaporate. At present, a very sticky hydrocarbon called oronite is being tested. Finally the covers are sealed together with acrylic cement. The individual modules are then placed in an aluminum housing whose base has been filled with styrofoam 22 that has been machined to fit. Six modules are connected in parallel and eight of these groups of six modules are connected in series. One housing contains a total of forty-eight modules or 432 cells. On a sunny day, such a set-up can produce nine watts of electric power.

Application

The last topic of importance is a consideration of the present and possible future applications of the

(Continued on Page 74)

TAMING THE ST. LAWRENCE



by

Richard L. Jarvis, CE '58

For many years the United States and Canada have realized the economic desirability of developing the St. Lawrence River. The feasibility of such a project was first worked out on paper more than fifty years ago, but until recently the tremendous cost involved prevented approval by the governments of the United States and Canada.

In 1952 representatives of the two countries met and agreed to the development of power in the International Rapids Section of the river. Responsibility for this phase of the project was placed in the hands of the Power Authority of the State of New York and the Hydro-Electric Power Commission of Ontario. The estimated cost of the power project was 600 million dollars, to be financed by the sale of bonds. In the early part of 1954 Congress provided a 105 million dollar limit to build the United States' portion of the seaway.

The St. Lawrence Seaway Development Corporation was designated as our agent responsible for its construction. The Corporations' indebtedness to the United States Treasury will be liquidated by tolls fixed through negotiations between United States and Canadian authorities. An additional 200 million dollars was appropriated by the Canadian government for the development of the seaway, bringing the cost of the entire project close to one billion dollars.

Certainly the cost of this project had not declined over the years, so what factors might have influenced its recent approval? In the past fifty years the heart of heavy industry in the United States has shifted from the East to the seventeen states bordering or tributary to the St. Lawrence Seaway and Great Lakes. Both the demand for, and production of raw materials in tremendous volumes have continually brightened the economic outlook of the venture. For instance, these seventeen states which support 35 per cent of our population produce 80 per cent of the iron ore, 40 per cent of the coal, 84 per cent of the automobiles, 75 per cent of the steel, 71 per cent of the corn, and 61 per cent of the wheat in the United States. The transportation of these bulky goods and raw materials is unquestionably cheaper by water than by rail and it is estimated that the tonnage shipped through the seaway in its first year of operation, 1959, will be 36.5 million tons, more than three times the present amount. The savings that business and trade make by shipping via the seaway will not be confined to those directly affected, but will be passed along to the consumer in the form of lower prices regardless of where he lives in the United States.

A cheaper mode of transportation means more industries, and more industries require power, bringing us to the second phase of this project. The St. Lawrence River is not only one of the largest rivers in the world, but is particularly suited for the production of hydroelectric power because of its uniformity of flow from season to season and year to year. The maximum flow recorded is only slightly more than twice its minimum flow. By contrast the flow of other rivers vary much more widely; the Columbia River with a ratio of 35:1, and the Mississippi 25:1.

A uniform flow of water through the turbines is essential for reliable power production which commands

a premium price. The St. Lawrence Powerdam will be the world's second largest hydro-electric power producing plant. Its thirty-two 57,000 kilowatt capacity generators will produce 1,880,000 kilowatts compared to 1,947,000 kilowatts generated at Grand Coulee Dam on the Columbia River. Already a great portion of this power has been guaranteed a market by industries in the United States, and all indications bear out the development of the St. Lawrence River as a sound business proposition.

Construction Problems

Besides being one of the largest developments of any river in the world, the construction of this project is further complicated by the necessity of maintaining all traffic and facilities using the river during construction. This required not only a master plan of construction procedure, but also close adherence to a construction schedule in order to prevent costly delays due to the interdependence of each phase of the project.

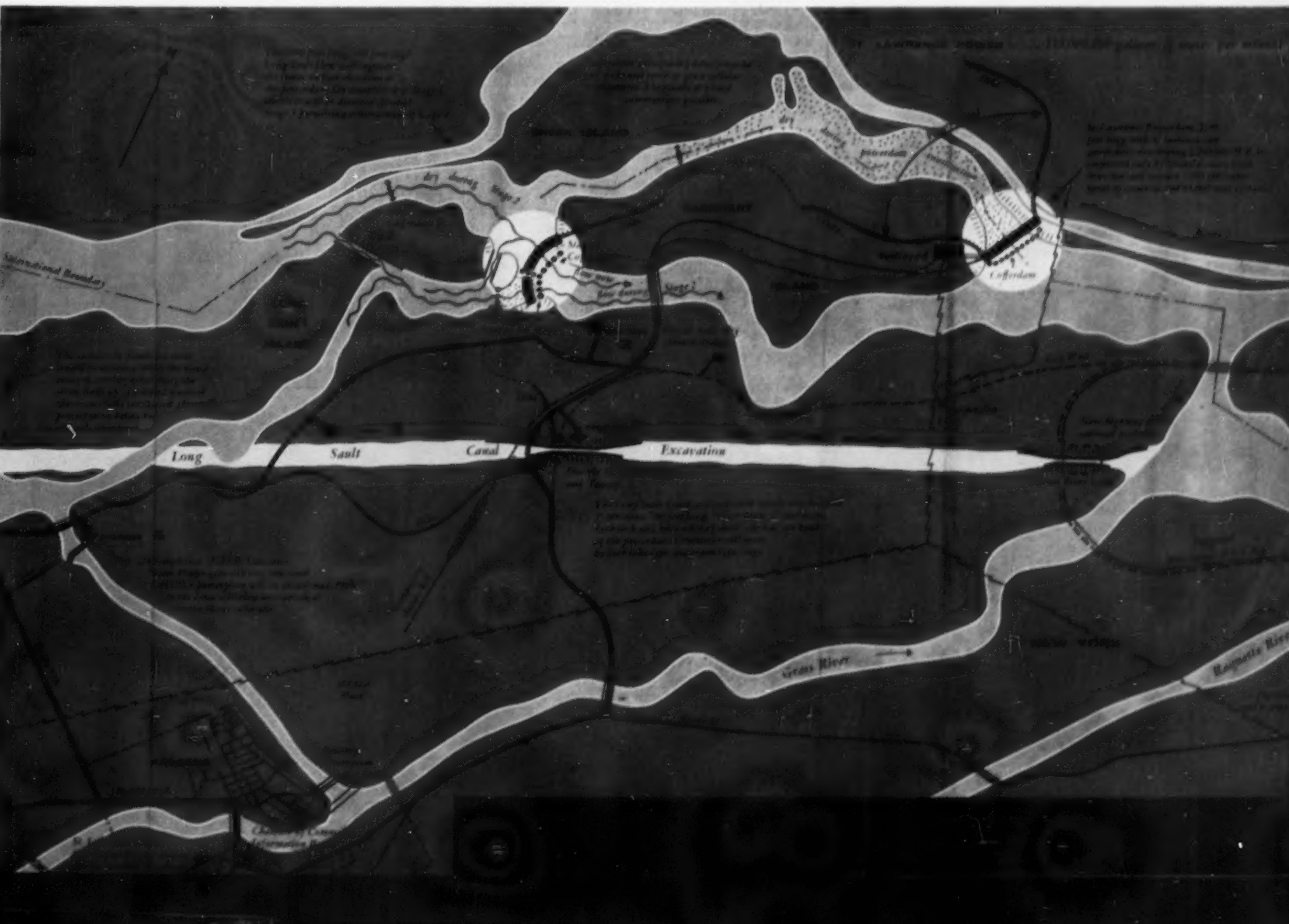
The largest structure to be built is the St. Lawrence Powerdam which will close the channel to the north of Barnhart Island and provide a power pool for its thirty two turbine generator units and sufficient depth for seaway traffic. The concrete gravity dam will be the fourth largest in the country, having a length of 3,300 feet, and an overall height of 167 feet. Since the construction of this dam involves the greatest amount of work, it was decided that the entire site should be put in the dry for the duration of the project. This was accomplished by placing temporary cofferdams across the north channel around Barnhart Island above and below the damsite. The entire flow of the river was then directed to the south of Barnhart Island.

Four miles upstream the Long Sault Spillway dam will eventually close this southern channel and regulate the depth of the power pool. The Long Sault is a concrete gravity dam with a curved axis having an overall height of 114 feet and a length of 2,960 feet.

The first stage construction of this dam involves the completion of the southern half made possible by a cofferdam enclosure. During this phase of the project the river flow was directed north of Long Sault Island, over the International Rapids, and south of Barnhart Island. Cut C through Long Sault Island enabled water flowing through the southern channel to pass north of the stage one construction area.

Upon completion of the southern portion of Long Sault dam, a rockfill cofferdam was placed across the river to the north of Long Sault Island. The water which had passed over the International Rapids was then diverted through cut F, a 600,000 cubic yard excavation through the island. At the same time cut C was backfilled and all the waters of the St. Lawrence flowed through the completed portion of the dam. With the completion of the stage two cofferdam construction for the northern half of the Long Sault could continue in the dry.

Twenty five miles upstream from the International Rapids, construction of the Iroquois dam had begun. Its primary purpose is to replace the natural rock weir near Chimney Point, a short distance downstream from Ogdensburg,



Map of the St. Lawrence Power and Seaway Project.

St. Lawrence Power Dam—General view of construction, looking north.

New York, which now controls the outflow from Lake Ontario and maintains its level between 242.5 and 249.5 feet above sea level. The dam is a buttressed concrete gravity structure with gate controlled sluiceway openings. Its total length is 2,335 feet, and is being constructed in two stages similar to the Long Sault dam.

At the present time navigation is being directed to the north of the construction area through existing locks and canals. Meanwhile the United States is constructing the 10 mile, Long Sault Canal which will pass to the south of the power dam. This phase of the seaway construction includes two locks; the upper to be known as Eisenhower Lock, and the lower as the Grass River Lock. The depth of the canal channel will be 27 feet, and have a minimum width of 450 feet. The locks will be 80 feet wide, 860 feet long, and have a maximum lift of 49 feet. In addition to the canal, over sixty three million cubic yards of excavation will have to be removed from river channels and adjoining shores to provide the minimum depth of 27 feet and safe river velocities not to exceed four feet per second.

Looking east at the Grasse River Lock—note backfill construction.

When the powerpool is eventually brought up to its proposed level, much of the surrounding countryside would be inundated were it not for the extensive system of dikes and embankments to confine the pool. These dikes will have a maximum height of 85 feet, a total length of 21 miles, and will include about 17,000,000 cubic yards of compacted embankment protected by rock riprap on the water pool side. There are many other structures being built such as water supply intakes, highways and bridges, power lines and even complete new towns, all of which are indicative of the tremendous size and scope of the river development.

Differing Construction Techniques

One of the most interesting features of this international project is the different methods of construction employed by the United States and Canada. Since the international boundary passes down the center of the St. Lawrence powerdam, one side is being constructed by Canada, and the other by the United States. Here we find two independent engineering organizations constructing nearly identical structures under the exact same conditions.

On first consideration one would think that an extensive cost analysis warranted on a job of this magnitude would lead both contractors to the same conclusion as to construction methods. And yet we find radically different methods on

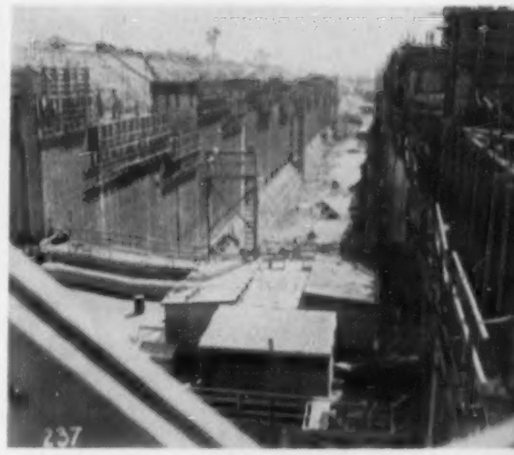
Eisenhower Lock—looking upstream.

items which are basic to the construction of a dam. For instance, the United States uses steel forms while the Canadians use wooden forms. The United States halts concreting operations in the winter months while Canada continues to pour twelve months a year. The United States places its concrete from buckets moved about by gantrys on track parallel to the face of the dam. The Canadians place their concrete from conveyor systems. What might be the explanation for these two approaches to what seems to be the same problem?

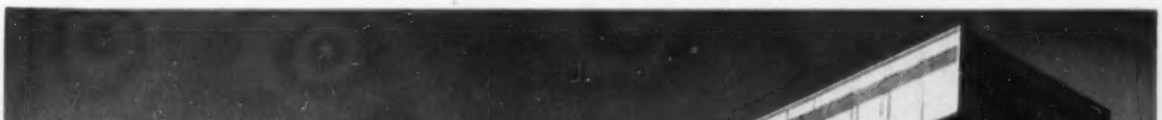
At first glance the Canadians and Americans seem to be working under similar conditions, but this is not the case. For instance there are wide variances in wage rates. A Canadian carpenter makes approximately $2 an hour while on the United States side a carpenter receives $3 an hour. This would explain our use of steel forms which require less time to erect and maintain although their initial cost is much greater.

The fact that Canada has decided to pour concrete through the winter is primarily a matter of experience. Since Canada has a much shorter period of warm weather than the United States, she has been forced to develop and practice cold weather concreting. Using tarpaulins to house the area being poured and salamanders to warm the air the Canadians were able to successfully place and cure concrete when the temperature dipped to 40 degrees below zero last winter. Another reason the Canadians have gone to winter concreting is their adoption of high concrete lifts which may be as great as 20 feet. These are much easier to protect from the inclement weather than a series of our standard five foot lifts.

A visitor to the St. Lawrence seaway and power project is probably most impressed by its size. Everything about it is big. An engineer would be most interested in the up to date methods of construction such as on the spot supervision in widespread areas made possible by television. The industrialist and business man might visualize the tremendous power which will soon be generated, and the new avenue of transportation which will extend into the heart of our country. But the development of the St. Lawrence River is more than a large engineering achievement with tremendous economic repercussions. The international planning and cooperation which made it possible is a tribute to two great countries, the United States and Canada, and an example to the rest of the world of what can be accomplished among friends.

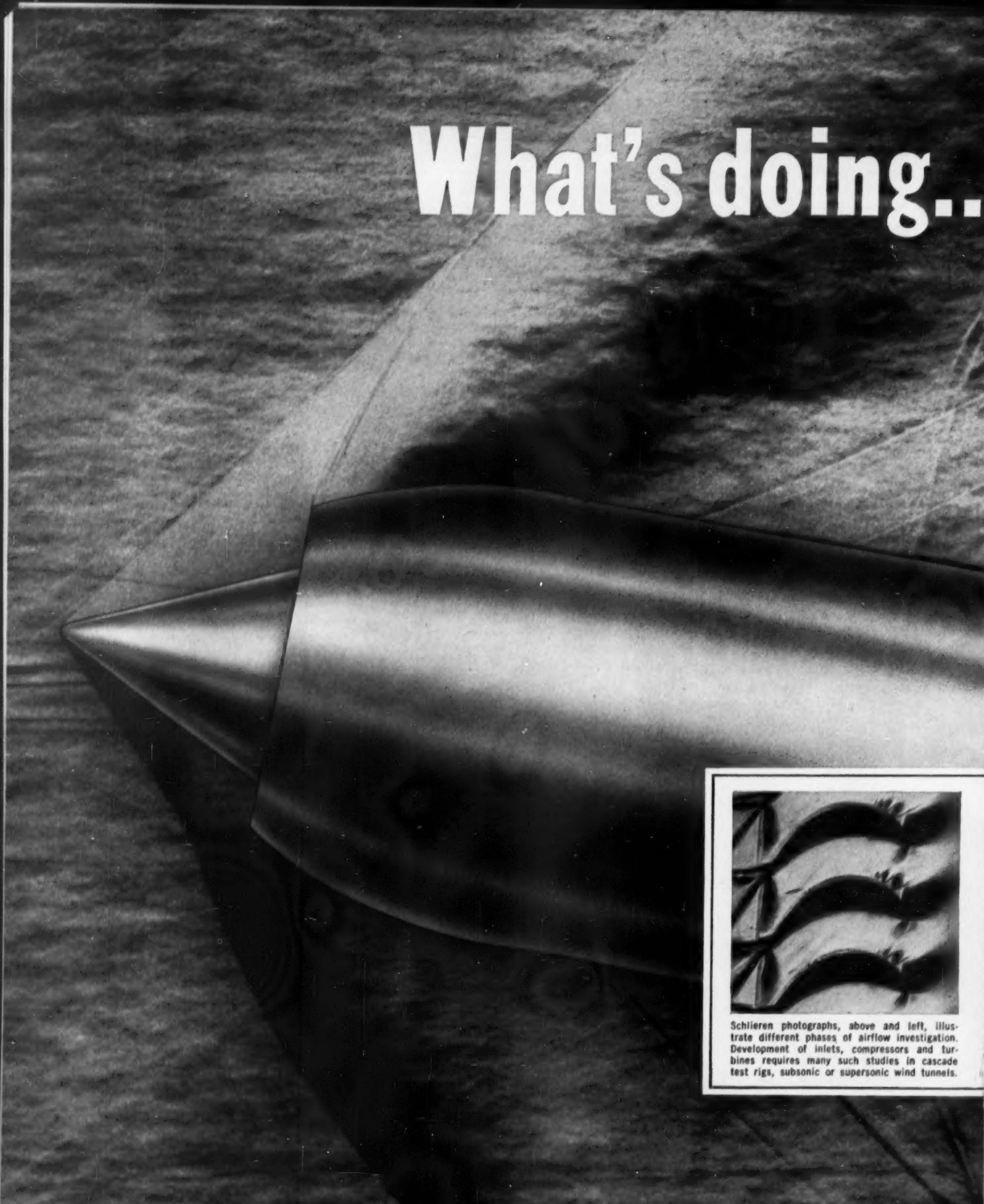


All pictures courtesy of the Power Authority of the State of New York.



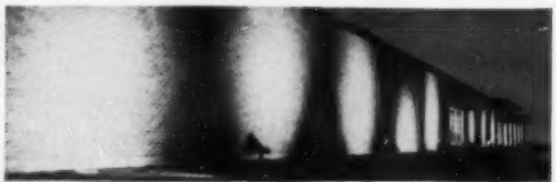
With the river diverted from the rapids section by Cofferdam "E" the full flow of the St. Lawrence flows through Long Sault Dam.

What's doing..



Schlieren photographs, above and left, illustrate different phases of airflow investigation. Development of inlets, compressors and turbines requires many such studies in cascade test rigs, subsonic or supersonic wind tunnels.

Creative Engineers . . .



Temco has a place for ***you*** *in this New Engineering Center*

At Temco, *growth* provides experienced engineers with challenging opportunities. They will find here rewarding assignments in electronics, guidance systems, jet aircraft, missiles and weapons systems.

This new 100,000-square-foot, air-conditioned Engineering Center typifies Temco's dynamic progress. More than 1,000 creative engineers work here. Here, too, is housed the most modern equipment available for the design and development of complete weapons systems. Diversified projects include work on recently awarded prime contracts for three Temco-designed missiles and jet aircraft.

TEMCO

AIRCRAFT CORPORATION • *Dallas, Texas*

Rapid expansion of research activities at Temco creates the need for a wider range of engineering skills. The engineer who has set exacting requirements for his future finds here a stimulating, creative atmosphere, and congenial associates.

In Engineering, the Best Opportunities are in Aviation

In Aviation, the Best Opportunities are at Temco

MR. JOE RUSSELL, Engineering Personnel
Room 100-N, Temco Aircraft Corp., Dallas, Texas

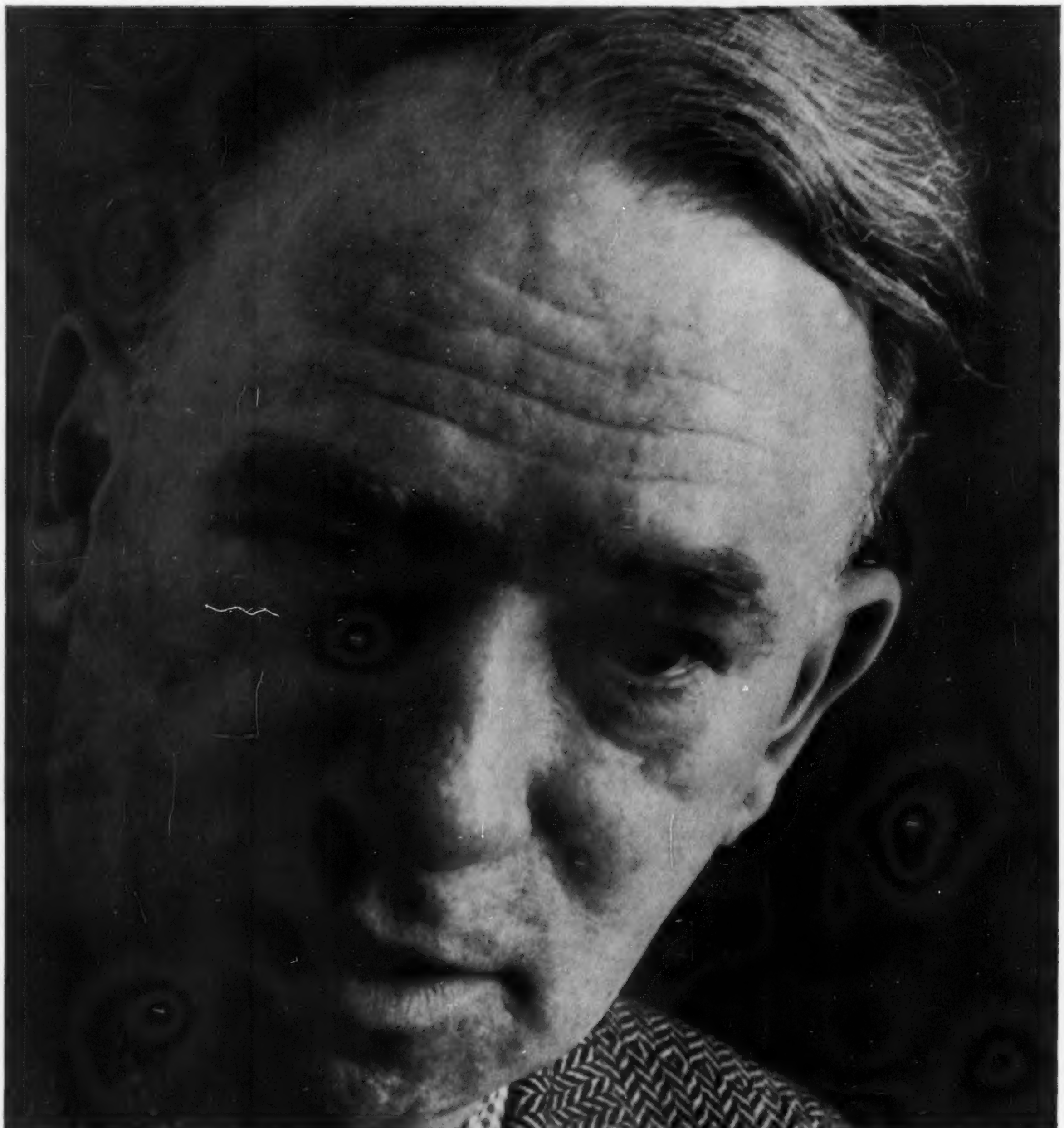
Please send me complete details of the Temco story of unusual opportunities for experienced engineers. I am especially interested

in ______________________

NAME ______________________

ADDRESS ______________________

CITY ______________ STATE ______________



YAVNO

CORNELL SOCIETY OF ENGINEERS

107 EAST 48TH STREET 1957-58 NEW YORK 17, N.Y.

ROSCOE H. FULLER, M.E. '24 .... *President*
17 Elm Street, Morristown, N.J.

DANIEL M. LAZAR, C.E. '29 .... *Executive Vice-President*
30 Vesey Street, New York 7, N.Y.

STEPHEN D. TEETOR, C.E. '43 .... *Secretary-Treasurer*
101 Park Avenue, New York 17, N.Y.

ELLIOTT R. THOMPSON, M.E. '24 .... *Recording Secretary*
Baldwin-Hill Co., Trenton 8, N.J.

Regional Vice-Presidents:

Delaware Valley:
JAMES W. JOHNSTONE, JR. .... 1700 Sansom Street, Philadelphia 3, Pa.

New England:
GERALD S. WHITE .... 231 Washington Street, Belmont 78, Mass.

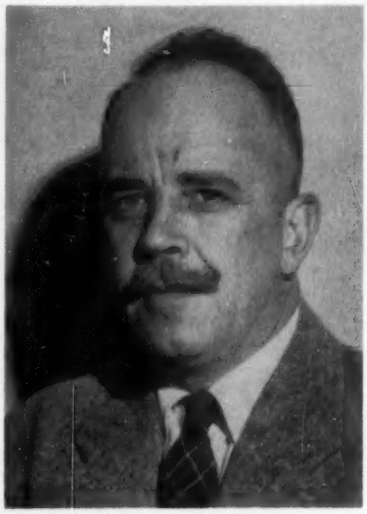
Chicago:
FRED M. GILLIES .... Acme Steel Co., Chicago 27, Ill.

Detroit:
L. IRVING WOOLSON .... P.O. Box 1628, Detroit 31, Mich.

St. Louis:
FRED HUME .... 4931 Lindell Boulevard, St. Louis 8, Mo.

Honorary President: S. C. Hollister, Dean, College of Engineering

Honorary Vice-Presidents:
C. H. Winding, Director, School of Chemical & Metallurgical Engineering
H. J. Loberg, Director, Sibley School of Mechanical Engineering
N. A. Christensen, Director, School of Civil Engineering
W. H. Erickson, Director, School of Electrical Engineering
T. R. Cuykendall, Director, Department of Engineering Physics
W. R. Sears, Director, Graduate School of Aeronautical Engineering



Roscoe H. Fuller

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationship between the College and its alumni."

THE PRESIDENT'S MESSAGE

Although our Society includes over 3,000 dues-paying members scattered all over the world, relatively few are aware of the day-to-day mechanics of running its affairs.

Since this is your Society you have a right to know how these things are conducted, and it is with the thought that this may be of interest that the following notes are presented.

1. During June or July of each year, the "Annual Letter" is sent out to all 18,000 Engineering alumni whose addresses are known, together with a solicitation for membership and a bill for dues.

2. The mailing lists are kept in the "Addressing and Mailing room in Ithaca, and are divided into four parts:
   List #1 consists of those whose dues are paid for the current year.
   List #2 includes those whose dues were paid for the previous year, but are not currently paid up.
   List #3 covers those who at some time in the past have been members, but not during the last two years.
   List #4 is the remainder of the Engineering alumni list, who have never seen fit to join the Society.

3. Every year during the summer, list 1 becomes list 2 for the next year, and list 2 becomes a part of list 3.

4. As membership returns come in to the Society's office in New York the checks are deposited and the membership cards sent to the A & M room in Ithaca, where the address plates are transferred to list 1.

5. The first issue of the "Cornell Engineer" goes to the entire membership list of the previous year, but subsequent issues go only to those whose dues have been paid; that is, to the current "list 1."

6. During the fall, two membership follow-up letters are sent out to those whose names are on lists 2 and 3, usually resulting in the receipt of dues from a great many former members who may have overlooked the first solicitation.

Unfortunately, due to the time delay involved in transmitting information from New York to Ithaca, and the clerical time required to make changes in the listings, there are always a few paid-up members who receive follow-up letters. For this we are truly sorry, and we sincerely apologize. Your Society operates with largely volunteer labor, and such delays are difficult to avoid. Nor are outright mistakes unheard of.

We ask that you bear with us, realizing the problems, and that you feel free to call errors to our attention, and to make any suggestions which would promote efficiency, accuracy or economy.

In addition to our regular members, the Society has for several years followed the practice of offering a year's free membership to each member of the current graduating class. We only ask that they return the member ship cards with their latest addresses indicated, so that the magazine will reach them.

The membership certificates, offered this year for the first time, present a different problem. There has been a delay in producing them, but they are in the hands of the printer, and should go forward in December to those whose orders we have received. Because the return card covering dues had no space to write your name and degrees as you wanted them on the certificate it was necessary in most cases to send out a supplementary letter to be sure that your wishes were respected.

It is our hope that these certificates will please you, and will occupy a respected place on your wall. If any member who has not done so wishes to order his, they are still available at $1.25.

While I think of it, there are still a few copies of the 1954 Directory of Cornell Engineers available at $1.00 a copy.

Please let me know what we can do to make this a bigger, better society; even more worth while to you and to our fellow alumni.

Roscoe H. Fuller

ALUMNI ENGINEERS

Troutware

Richard S. Stewart

Richard S. Stewart, ME '32 vice president and assistant to the president of The Standard Oil Company (Ohio), has been named Vice President for Production.

Mr. Stewart will be responsible for all exploration and production operations of Sohio and its subsidiaries, reporting to Charles E. Spahr, executive vice president.

In 1955, Mr. Stewart served a year as president of Iricon Agency, Ltd., representing nine American oil companies with crude oil production, refining and export rights in Iran.

He was chairman for the 1956 campaign of the American Red Cross in Cleveland.

He joined Sohio as a power engineer in 1938, after six years' experience in refinery operations with The Texas Company in Texas.

In 1945, Mr. Stewart was named operations manager for Sohio's manufacturing department refineries and plants; served for a short time as manager of Sohio's department of industrial relations, and became assistant to the president upon Mr. Foster's election to that office in April, 1949.

Mr. Stewart was elected a vice president in 1954 and continued as assistant to the president.

During the early part of World War II, he was Sohio's representative to the Petroleum Administration for War in matters concerning the construction of Sohio's aviation gasoline refining units. He also was on special assignment with the Navy at the request of the late Frank Knox, then Secretary of the Navy.

Monroe D. Edelman, BChem, '33, is assistant to the president of Julian Laboratories, Inc., manufacturers of pharmaceutical chemicals.

Francis W. Watlington EE '40, '47, is chief electronics engineer at Columbia University geophysical field station in Bermuda, where he works primarily on underwater acoustics. He has a daughter and son and lives at "Corolita," Pitts Bay Road, Pembroke, Bermuda. The mail address is c/o Sofar, APO 856, New York.

S. James Campbell, BChemE, '43, '44, is president of the Associated Builders & Contractors of Maryland and vice-chairman of the Baltimore County Revenue Authority. The Campbells live at 1904 Indianhead Road, Ruxton 4, Md. A daughter, Mary Carol Campbell, was born to them December 18, 1956.

George R. Chambers BEE, of Buffalo, N.Y., has joined the Electronic Instrumentation Division, The Ramo-Wooldridge Corporation.

An electrical engineer, Mr. Chambers has experience in wind tunnel instrumentation, airborne fire control systems, advanced fire control and missile guidance systems, moving target indicator and receiver circuit design, and ground radar systems.

He is a member of the Institute of Radio Engineers, Cornell Society of Engineers and an associate member of the American Institute of Electrical Engineers.

Mr. Chambers resides at 4924 W. Elmdale Drive, Rolling Hills.

M. D. Morris, CE, '44, has become vice president in charge of Engineering and Sales of the TESTlab Corp. and will operate its New York region offices. **John P. Gnaedinger, BCE '47** will act as a consultant.

TESTlab is a newly formed corporation, engaged in the manufacture and marketing of apparatus and equipment for the engineering testing of soils, bituminous, and concrete materials. The new feature of electronic recording devices will be provided by close association with the **Tinius Olsen ('33)** Testing Machine Company, who will also provide a world-wide sales and service organization.

George A. Rumsey '93 (below) reads the Zeta Psi publication in his home at 1307 Ocean Avenue, Spring Lake, N.J. He has always been active in the Cornell chapter. Rumsey is chairman of Rumsey Electric Co., 1007 Arch Street, Philadelphia 5, Pa., which he and his brother, the late **Eugene A. Rumsey '90,** founded in 1895. From 1902-15, the company installed more than 125 central stations, among them Dover, Del., York, Pa., Dam 4 and 5 Potomac, and Martinsburg, W.Va.

(Continued on Page 82)

Alumni News

George A. Rumsey

howard hughes fellowships

Ten awards are open to candidates interested in studies leading to a Doctor of Philosophy or Doctor of Engineering degree or in conducting post-doctoral research.

Each Fellowship provides a cash award of not less than $2000 . . . a minimum salary of $2500 for summer or part-time work . . . up to $1500 for tuition, books, and research expenses . . . and moving and transportation costs. Eligibility is based on the completion of one year of graduate work in physics or engineering, and qualification for graduate standing at California Institute of Technology, University of California (Berkeley), or Stanford University. Application closing date: January 15, 1958.

master of science fellowships

One hundred awards are open to participants who will complete courses leading to the Master of Science degree within 2 academic years. Tuition, admission fee, and books will be provided. During the summer and part-time during the academic year they will have the opportunity to work with experienced Hughes scientists and engineers, while receiving salaries based upon their ability and technical experience.

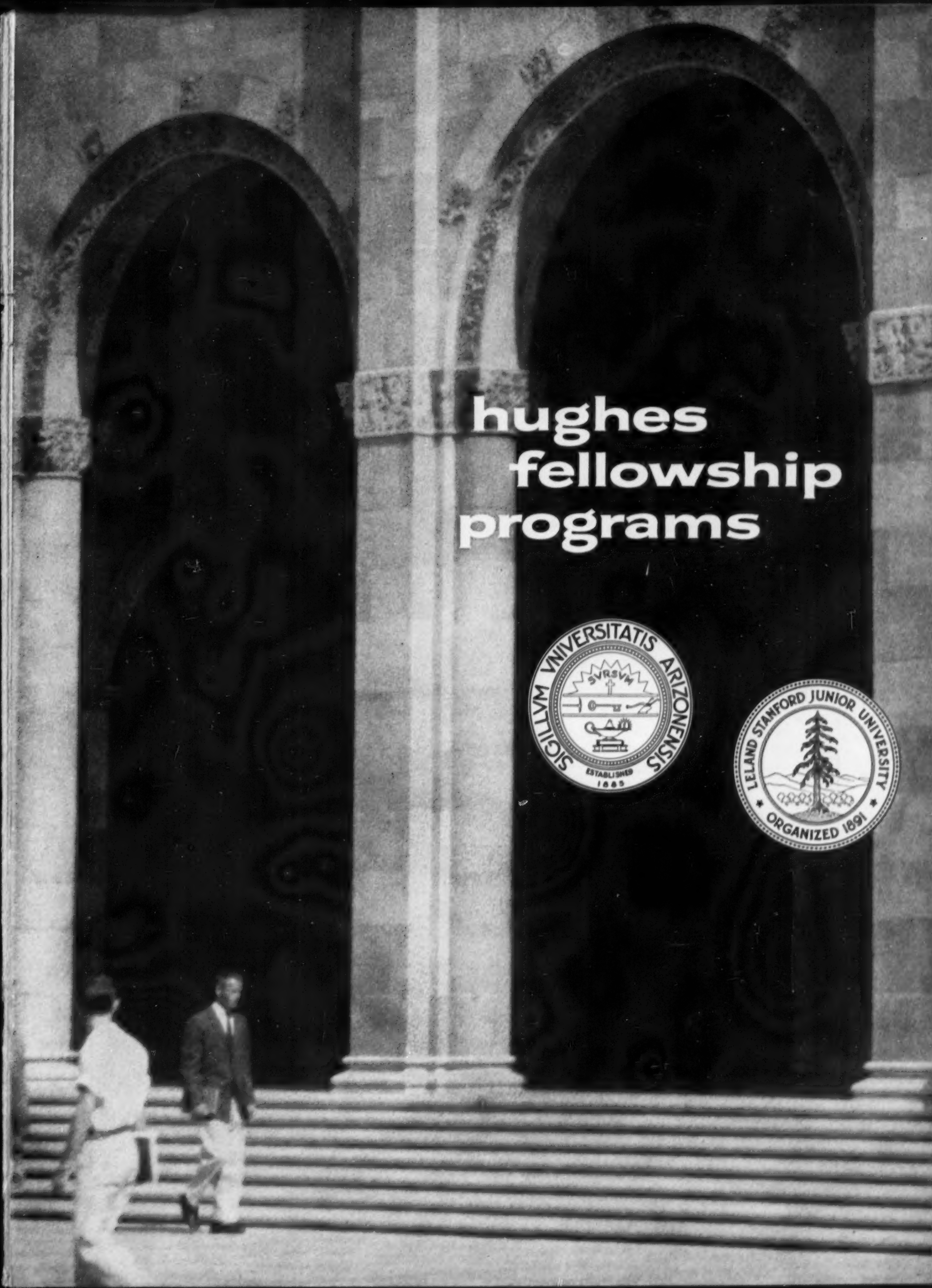
Applicant must receive his B.S. degree during the coming year in Aeronautical Engineering, Electrical Engineering, Mechanical Engineering, or Physics. Participant may request his graduate school from the following six institutions: University of Southern California, UCLA, Stanford University, University of Arizona, Purdue University, or West Virginia University.

Write, specifying appropriate fellowship, to:
Office of Advanced Studies

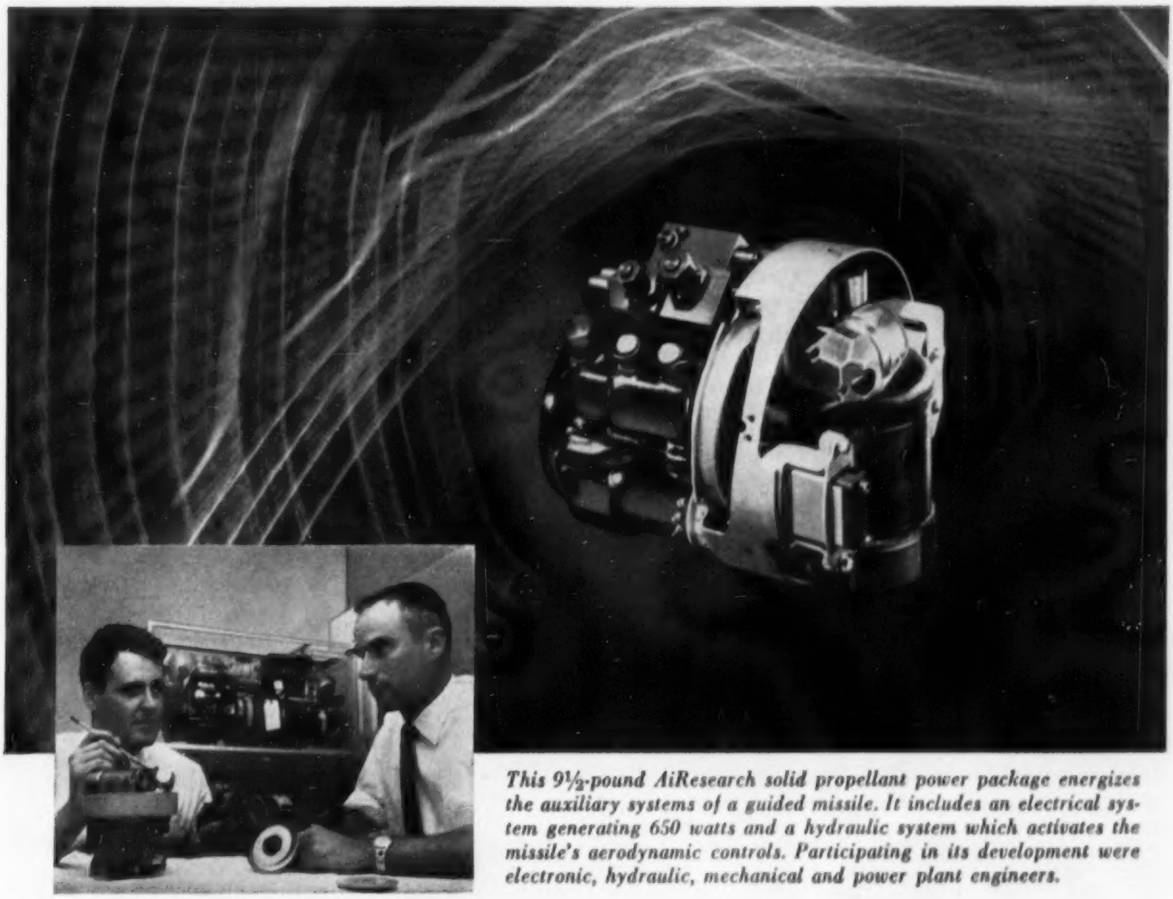
HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Hughes Aircraft Co., Culver City, Calif.


hughes
fellowship
programs
SIGILLVM VNIVERSITATIS ARIZONENSIS
SVRSVM
ESTABLISHED
1885
LELAND STANFORD JUNIOR UNIVERSITY
ORGANIZED 1891

IF you're looking beyond tomorrow...



This 9½-pound AiResearch solid propellant power package energizes the auxiliary systems of a guided missile. It includes an electrical system generating 650 watts and a hydraulic system which activates the missile's aerodynamic controls. Participating in its development were electronic, hydraulic, mechanical and power plant engineers.

Your first position after graduation will determine the direction in which you will grow in engineering knowledge and ability.

Garrett offers engineering career opportunities which will expand for many years to come.

They include the following in the fields of aircraft, missiles and technological industry: system electronics; computers and flight instruments; gas turbine engines and turbine motors; prime engine development; cryogenic and nuclear systems; pneumatic valves; servo control units and air motors; industrial turbochargers; air conditioning and pressurization and heat transfer.

In addition to direct assignments, a 9-month orientation program is available to aid you in selecting your field of interest. This permits you to survey project, laboratory and administrative aspects of engineering at Garrett. With company financial assistance you can continue your education at outstanding universities within easy reach of your employment.

Project work is conducted by small groups where individual effort is more quickly recognized and opportunities for learning and advancement are enhanced. For full information write to Mr. G. D. Bradley.

THE GARRETT CORPORATION

9851 S. SEPULVEDA BLVD., LOS ANGELES 45, CALIFORNIA

DIVISIONS: AIRESEARCH MANUFACTURING, LOS ANGELES • AIRESEARCH MANUFACTURING, PHOENIX • AIRSUPPLY
AIRESEARCH INDUSTRIAL • REX • AERO ENGINEERING • AIR CRUISERS • AIRESEARCH AVIATION SERVICE

TECHNIBRIEFS

GIANT LEGS LIFT OIL DRILL BARGE ABOVE OCEAN WAVES

"Vinegaroon", the second precedent-setting mobile off-shore drilling platform to be placed into coastal tideland drilling service, was commissioned recently at New Orleans, Louisiana. After formal christening ceremonies, the 2500-ton behemoth immediately departed for its first drilling site in the Gulf of Mexico. The rig's initial operations will take place 15 miles off of Cameron, Louisiana, where it will drill in 35 feet of water.

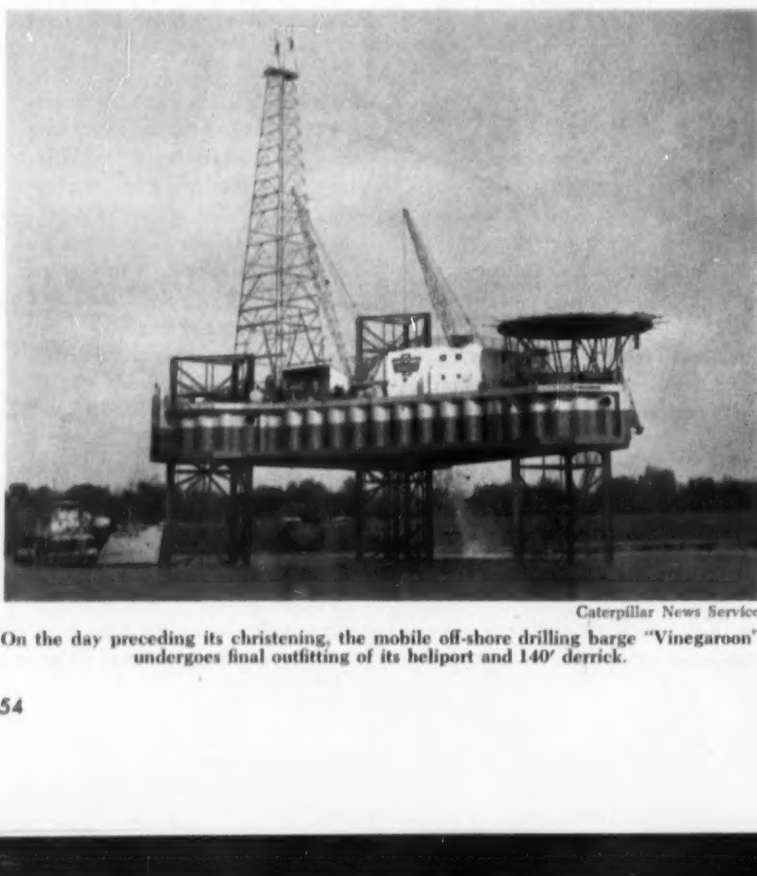
The "Vinegaroon" is a triangular, floating barge, equipped with three electro-mechanically controlled spuds or legs. The giant legs, each operating in 36 foot spud wells, lower to the ocean floor when located over a drilling site, elevating the hull structure to the desired height above the water. The legs are 145 ft. in height, and are made of truss-braced tubular steel, combining strength and regidity, with the ability to minimize adequately the effect of heavy seas. Three gear racks are mounted integrally on each of the legs, and are driven by final drive pinions actuated gear-motors.

The feet of the elevating legs are spud tanks 35 ft. in diameter, and 32 ft. high, which are filled with water when the legs are lowered. Having concave bottoms, the spud tanks are designed to provide a sure grip in securing dependable footing on the ocean floor.

Powering the three supporting legs are 27 electric motors, nine in each spud housing, which drive the legs through 6,000 to 1 gear reductions, and derive power from three 440 volt, 60 cycle, 3-phase A.C. generators. Power for the generators is provided by three turbo-charged diesel engines, set for 600 HP (intermittent) at 1200 rpm. One of these generator combinations supplies power for ship's service, as well as providing stand-by power for lowering the legs.

Sufficient power is supplied by the power equipment to allow all three legs to be raised or lowered simultaneously. Fully loaded, the new drill rig may be raised at a rate of 16 in. per minute, and lowered at 18 in. per minute. The average height of the platform above the water during drilling will be approximately 40 feet.

The "Vinegaroon's" platform hull is 176 ft. long and 151 ft. wide, with a depth of 20 ft. Loaded draft of the rig is 11 ft. 6 in. The hull sides and outer bottom are made of corrugated steel. Deck structures and platform inner bottom are fabricated of flanged steel plates. Between the platform's double bottom are arranged compartments for the storage of drilling water, potable water, and diesel fuel.



Caterpillar News Service

On the day preceding its christening, the mobile off-shore drilling barge "Vinegaroon" undergoes final outfitting of its heliport and 140′ derrick.

FLIGHT MAPS PRODUCED IN TWENTY SECONDS BY RADAR

Airplane pilots and navigators can now consult a map that is only twenty seconds old made night or day in flight by radar. With a device called a radar strip recorder which presents a photograph of the ground beneath the airplane as seen by airborne radar eyes, navigation to pin point accuracy is now possible. The airborne system is equally useful in peace or war.

Previously navigators and pilots have had to rely on memory or hasty notes and calculations taken from radar presentations in the air. The new automatic device requires no operator; it combines electronics and photography to make it easy to determine the airplane's exact position and true flight path at any time desired in flight without relying upon memory or radio equipment on the ground.

Initially designed for use with an airborne radar system, the strip recorder with its associated fast film processor is adaptable to practically all types of airborne radar. In addition, the device is useful as a ground recorder of radar or telemeter information relayed from flying radar sets. In such uses, the strip recorder makes it a simple matter for ground controllers and observers to monitor the flight path of a missile or drone aircraft. Hycon Mfg. Company is the designer of this system.

Instrumental in making the rapid strip recorder feasible is a unique process evolved by Hycon for developing high sensitivity film in only ten seconds. The process uses only one liquid bath, which functions at a high temperature to speed the photographic development. Liquid is literally wiped onto the

9-inch wide film in the radar strip recorder much the same as painting walls with a squee-gee. The transparency which emanates from the monobath developer is then viewed directly on a translucent lighted screen about the size of a sheet of notebook paper. The recording and development process is continuous, so that the pilot, navigator, or other observer sees a slowly moving portion of a long strip of film which is automatically wound up on a roller in the machine. The roll of film is a permanent record which can be used for reference or later compared to other flight records. If desired, prints or other negatives can be made from the transparency roll.

High precision optics and advanced electronic techniques went into the development of the radar strip recorder. The optical system includes mechanical adjustments which enable the pilot or observer to correct manually the machine for airplane wind drift. This wind drift adjustment results in a rectilinear record which maps the ground accurately along perpendicular axes, regardless of wind conditions at high altitude. In addition, special electronic circuits built into the recorder automatically correct for distortions due to the altitude of the aircraft.

Working equally well day or night, above clouds or in clear weather, the radar strip recorder promises to revolutionize air navigation by combining the accuracies of radar, the convenience and utility of photography and the speed of electronics.

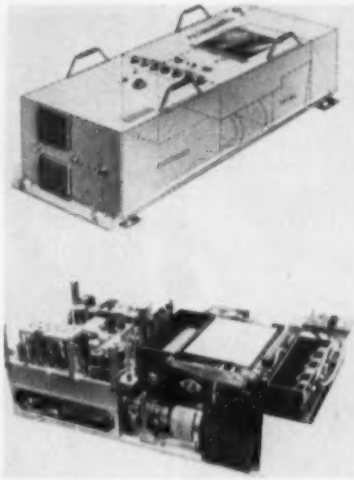
• TANK COMPARTMENT SHOCKS SIMULATED TO DESIGN TANKS

An "automatic engineer" that helps to design tanks is now under development by Lehigh Engineering Associates of Newark, New Jersey.

This unusual project—a tank fighting compartment simulator—is being developed for the United States Army.

Not a training instrument, the simulator is devised to reproduce the various forces which act upon a tank fighting compartment and on the gunner in it.

The simulator obtains immediate results, saving valuable design time and months of calculations.



Radar Strip Recorder

• MOBILE COMBAT COMPUTER SOLVES BATTLE STRATEGY

A new mobile electronic "combat computer" for solving military problems ranging from battle strategy and tactics to logistics is being developed by Sylvania Electric Products Inc. for the U.S. Army.

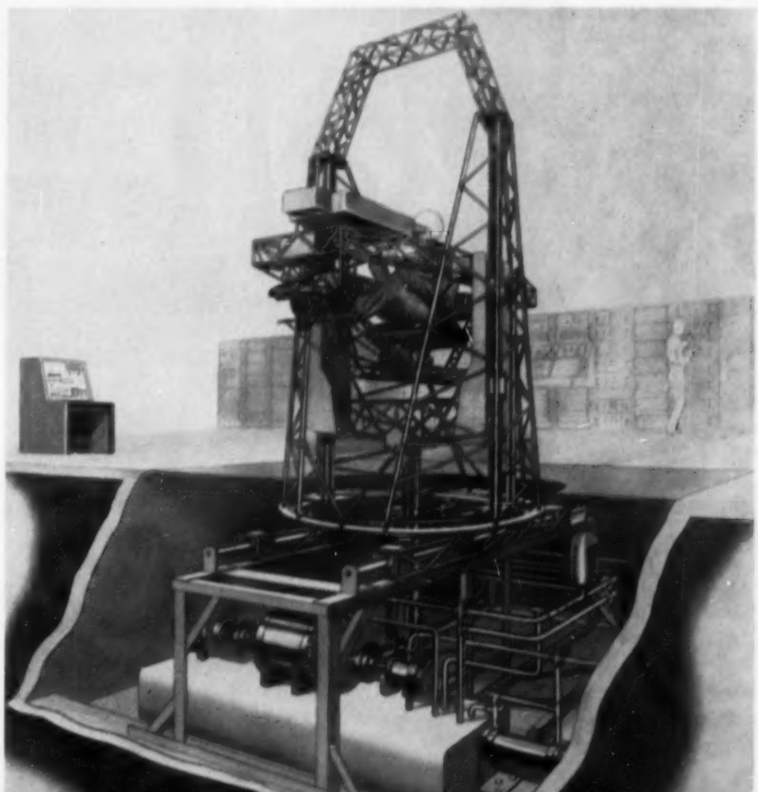
The mobile field computer will fit into a standard trailer, about 28 feet long, instead of requiring a large specially designed room as most complex electronic "brains" do. Air-conditioned, it will be able to function effectively in extreme climates and under grueling battlefield operating conditions anywhere in the world.

Subminiature components, such as transistors, and circuitry of the most advanced design will give MOBIDIC rugged compactness combined with high reliability and versatility.

A significant feature of the new computer is its expandability and high flexibility within the trailer. Tape devices for feeding data into the computer and recording answers, and additional magnetic core "memory" storage units can be added or changed to meet requirements of particular types of problems.

The special uses for which MO-

(Continued on Page 59)



Lehigh Engineering Associates

Integrated Fighting Compartment Simulator.

NEW PRODUCTS CORPORATION
INTEGRITY
QUALITY
SERVICE
Cornerstones of the NPC Corporate Character . . . Expressed in
NPC
Die Castings
Aluminum-Zinc-Magnesium
The NPC Corporate Character, expressed in the craftsmanship of every product, assures you of the highest quality in designing, tooling, casting, machining and finishing of die castings in zinc, aluminum or magnesium.
HOME APPLIANCES
OFFICE EQUIPMENT
PHONOGRAPHS
ELECTRONICS
AIRPLANES
HAND TOOLS
CAMERAS
Industry finds integrity, quality and service in NPC products. Mindful of this deep responsibility, everyone at NPC continually strives to maintain the highest of standards. Tool makers and production craftsmen that take pride in their work, utilizing the latest in modern machinery, enable NPC to perform a broad service for varied industries.
NEW PRODUCTS CORPORATION
P. O. BOX 666 • BENTON HARBOR 1, MICHIGAN
Since 1922

TECHNIBRIEFS

(Continued from Page 55)

BIDIC is being developed include logistics, combat surveillance, scientific or analytic computation, and such application as air traffic control and artillery target assignment.

A typical logistics problem which MOBIDIC would solve for a tactical field force would be the control of inventory of vital battle supplies from weapons and ammunition to rations. If the computer determines that a vital item is not available locally, it would automatically initiate a request for the supplies from the next higher source.

In combat surveillance, the computer would be able to process swiftly a large quantity of data and information, ranging from enemy troop movement reports to results of prisoner-of-war interrogations, to help the field commander make tactical decisions.

● CHEMICALS TRANSFORM SAND TO SOLID ROCK FOUNDATION

A man-made, subterranean solid sandstone dike is part of the foundation excavation for a New York City skyscraper. This dike was created by controlled injections of chemicals from the surface that turned water-bearing sand and gravel into impervious rock.

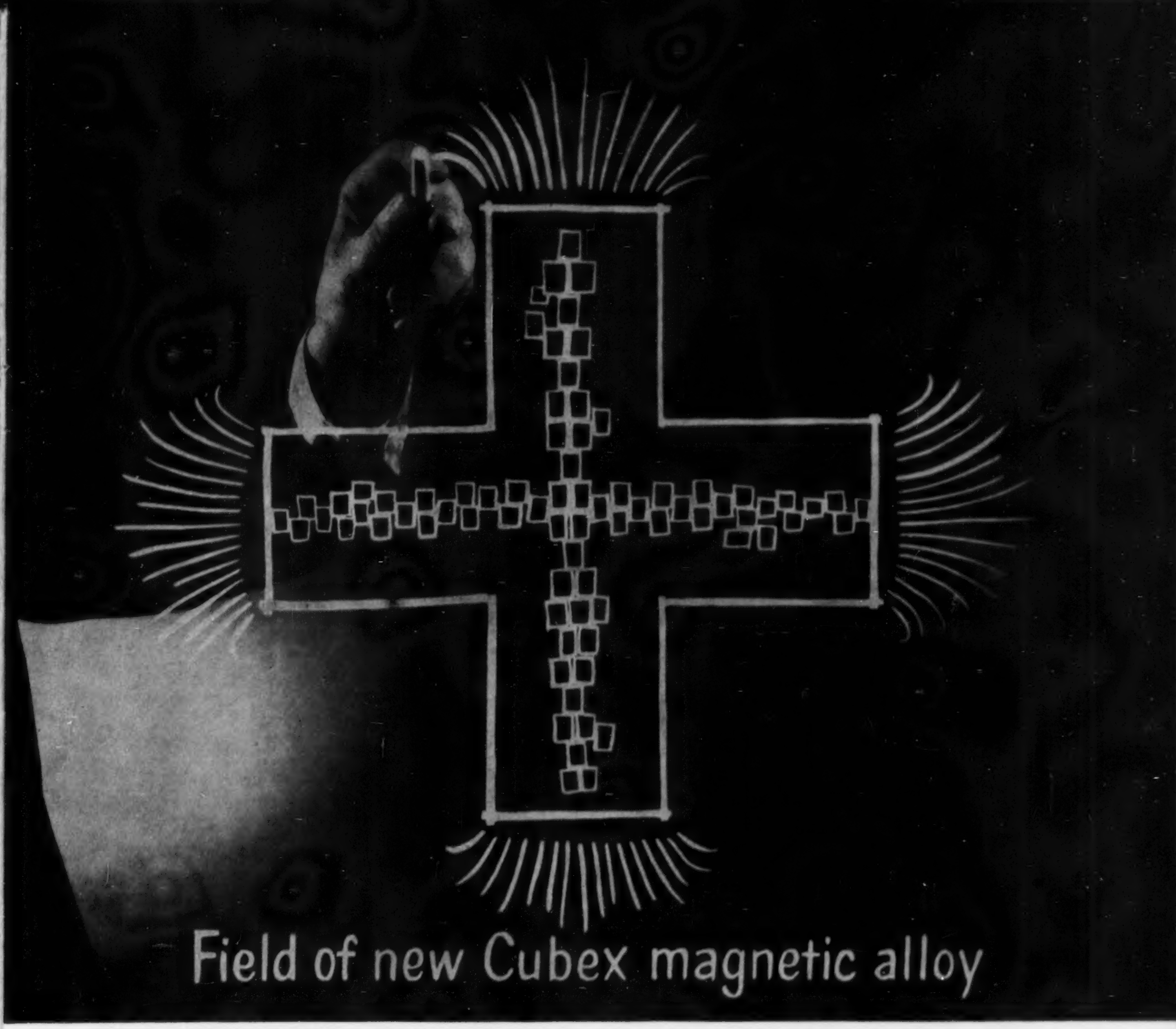
Ground at the construction site of the 60-story Chase Manhattan Bank was divided into four layers. The top layer was silt and sand, next came a layer of hardpan and boulders, then sand, gravel and boulders, and finally bedrock.

Before the thick foundation walls could be erected on the bedrock, the layer of sand and gravel had to be dried out and tightened. To sink a line of concrete box caissons under air pressure to seal off the wet strata, would have been expensive and time consuming.

Instead, the foundation company alternately injected sodium silicate and calcium chloride solutions through 160 injection pipes into the wet ground.

Reacting with the sand and gravel to form a sort of sandstone, the chemicals solidified a watertight barrier some five-feet thick, extending from bedrock to hardpan.

Nearly 59,000 gallons of sodium silicate were injected. They were augmented by 200 tons of bagged calcium chloride.

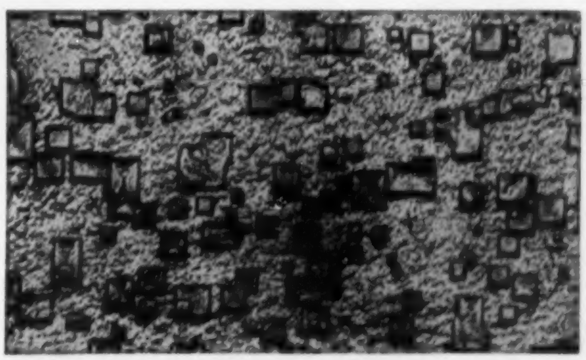


Laboratories. Dr. Wiener got his B.S. in 1943 from University of Wisconsin. In 1953 he earned his Ph.D. at University of Pittsburgh while working at Westinghouse and studying on tuition-free Graduate Study Program.

BREAK THROUGH MAGNETIC BARRIER:

cube-oriented alloy

For more information on Westinghouse research in the field of magnetism, or information on job opportunities, write to Mr. J. H. Savage, Westinghouse Electric Corporation, P.O. Box 2278, Pittsburgh 30, Pa.



Cube-orientation of crystals in Cubex is revealed by "etch pits" in this photomicrograph. Cubex is a silicon-steel alloy, easily magnetized in four directions instead of two.

Westinghouse

FIRST WITH THE FUTURE

COLLEGE NEWS

CORNELL GRAD STUDENT TRACKS SPUTNIK ORBIT

Mr. Robert Hufnagle, a graduate student in engineering physics at Cornell, has been tracking the Soviet earth satellite as a part time project. Mr. Hufnagle with the aid of his war surplus shortwave radio has compiled surprisingly accurate data on the orbit of the satellite as it passes over Northeastern United States.

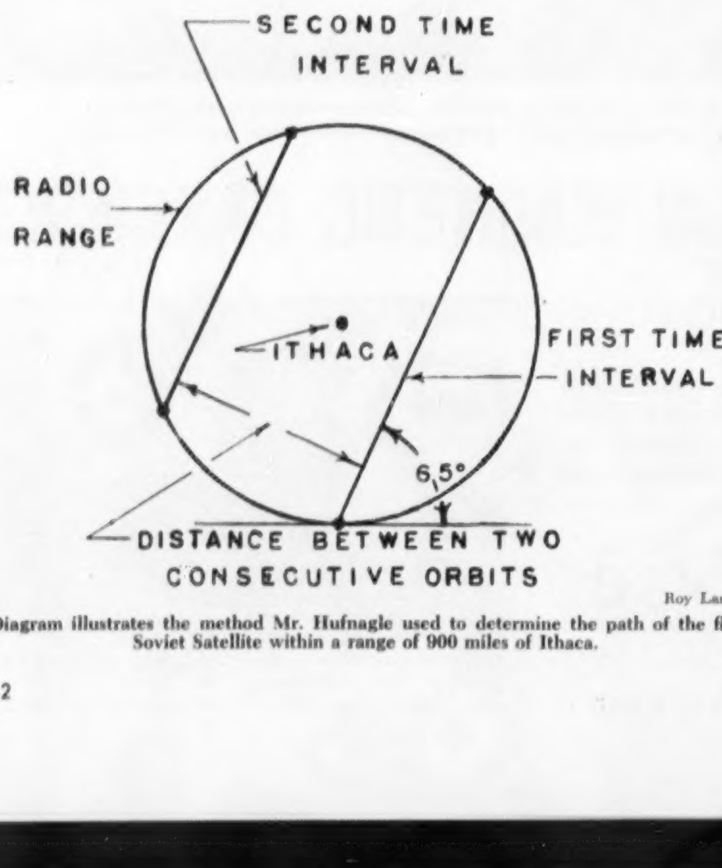
The system he uses is surprisingly simple. Each night he tunes his radio to the frequency of the signal emitted by the satellite. He then listens and records the time interval from when he first hears the signal until it fades away. The length of this interval depends upon how close the satellite approaches Ithaca. After making two such consecutive readings, Mr. Hufnagle is ready to plot the path of the satellite within a range of 900 miles from Ithaca.

While the satellite's orbit is essentially stationary, the earth it circles is rotating. Thus two consecutive revolutions of the satellite will trace two paths on the earth a given distance apart. This distance Mr. Hufnagle computed from the satellite's period of revolution and the earth's rotational velocity.

From the time interval and the velocity of the satellite he found the distance it traveled during the times he heard it. He then marked these lengths down as two parallel lines at a distance apart proportional to the distance between the two paths of the satellite traced upon the earth from two consecutive revolutions of the satellite. The four points formed by the ends of these two parallel lines determine a circle whose radius is equal to the range of his radio and whose center is at Ithaca. Having located Ithaca in relation to the two paths traced on the earth by the satellite, it was easy to draw a perpendicular line to the paths and determine how close the satellite approached Ithaca.

According to Mr. Hufnagle, the satellite passed directly over this area on October eighth and again on the fifteenth.

Mr. Hufnagle's method is based upon two assumptions. The first is that the radius of reception of his radio remains constant. The second is that the angle the satellite's orbit makes with the latitudes of the earth is sixty five degrees. Mr. Hufnagle stresses that this second fact has only been reported by the Soviets.



Roy Lamm

Diagram illustrates the method Mr. Hufnagle used to determine the path of the first Soviet Satellite within a range of 900 miles of Ithaca.

PROF. ROY CLARK RETIRES; TAUGHT 15,000 STUDENTS

Roy E. Clark, who has taught at Cornell since his graduation from the university 44 years ago, has become a professor emeritus of thermal engineering.

Professor Clark estimates that about 15,000 students have passed through his classes in thermodynamics, power plants, turbines and other courses in the department.

Besides his academic life, Professor ("Pop") Clark has been active in many Ithaca groups. He was a charter member of the American Legion Ithaca Post 221, in 1918.

He was also a charter member of the Ithaca Stamp Club, the Kiwanis Club, the Barber Shop Quartet and Balbec Grotto.

Many Ithacans know first-aid techniques because of Professor Clark's instruction in American Red Cross first-aid over a period of 25 years. He spent 25 years in Boy Scout work too, serving as scoutmaster of Troop 7 at the First Methodist Church and for 10 summers as business manager at Camp Barton.

One of Professor Clark's current good deeds is sharing with Marion Mack, Boynton Junior High School art teacher, an elaborate painting job in the interior of the First Methodist Church and its new addition.

Professor and Mrs. Clark, the former Ina Williams of Ithaca, plan a really foot-loose retirement—to sell their home here and travel. He says they want to spend several weeks in each of the states they have passed through, plus Washington and Oregon, the two they

missed, and to take in Europe, Alaska, Hawaii, South America and the West Indies as well.

Professor Clark was born in Norwood, N.Y., and throughout high school worked evenings, weekends, and summers in the now defunct Norwood Paper Company.

By working a year after high school and another in the middle of his college course, and with the help of a New York State Tuition Scholarship of $200 a year, Professor Clark put himself through Cornell. He received a mechanical engineering degree in 1913 and began to teach the next fall. The starting salary for instructor was then $800 a year.

During World War I he was an engineer with the Army Ordinance Department, stationed at a shell-loading plant at Mays Landing, N.J.

INDUSTRY, SCHOOL HONOR PROF. RHODES IN NEW YORK

Professor Fred H. "Dusty" Rhodes, founder and first director of Cornell's School of Chemical Engineering, was honored at a recognition dinner held in New York City on October 28. The dinner, sponsored by leaders of industry and education, was in recognition of Dr. Rhodes' pioneering leadership in the development of chemical engineering education and the profession of chemical engineering.

John M. Olin, Chairman of the Board of Olin Mathieson Company and H. F. Johnson, President of Johnson's Wax Company, spoke for industry before the gathering. S. C. Hollister, Dean of the College of Engineering, and Charles C. Winding, successor to Dr. Rhodes as director of the School, also addressed the gathering. Mr. Sidney Kirkpatrick, Editorial Director of the trade magazines "Chemical Engineering" and "Chemical Week", acted as toastmaster.

Professor Rhodes was born in Rochester, Indiana in 1889, graduated from Wabash College in 1910 and came to Cornell in the same year for his Ph.D. Receiving his Ph.D. in 1914, he went to the University of Montana, where he taught chemistry for a year. He then returned to Cornell as a chemistry instructor. From 1917 to 1920 he worked for the Barret Company, becoming Director of Research. In this period he was in on many of the developments that have become the basis of chemical engineering.

He returned to Cornell in 1920 to teach industrial chemistry. It was at this time that he initiated his crusade for chemical engineering at Cornell. Finally, in the 1930's Dusty convinced the University and a degree of chemical engineering was offered to chemistry graduates who took an extra year under his direction. In 1938 a separate School of Chemical Engineering was established with Professor Rhodes as director. The School has grown at a rapid rate until today there are 403 undergraduates and 14 full time staff members.

Professor Rhodes, whose sense of humor is well known, liked to answer his telephone as follows:

"This is Fred Hoffman Rhodes, Director of the School of Chemical and Metallurgical Engineering, Herbert Fisk Johnson Professor of Industrial Chemistry and Personnel Officer of the School." He then insisted that the caller address him as Dusty.

At the dinner the alumni and friends of Dr. Rhodes presented him with a symbolic gift representing $350,000 which is being raised to endow the Rhodes Chair of Chemical Engineering at Cornell in his honor.

DISTANCES SURVEYED TO ONE PART PER MILLION

The Tellurometer, an electronic device which makes use of electromagnetic waves to measure long distances with accuracies up to one part per million, was demonstrated at Cornell University's Fuertes Observatory at two sessions on Friday, October 25.

The instrument, developed recently in South Africa, was demonstrated by Floyd W. Hough (Cornell '19) and Robert Thurrell, members of Tellurometer, Inc., Washington, D.C.

The line measured extended from the U.S. Coast and Geodetic Survey station "University" near the Observatory to another station known as "Enfield" approximately 6⅛ miles west of Ithaca on the Mecklenburg road. The distance had already been measured by conventional ground methods.

In connection with the demonstration, the Central New York Section of the American Society of Photogrammetry met for dinner at the Statler Student Cafeteria on Friday evening at 6:30. The dinner was followed by a talk on the uses of the Tellurometer in geodetic, photogrammetric and highway surveying. The question of

(Continued on Page 66)

At Professor "Dusty" Rhodes banquet in New York: Back row, left to right: Sidney D. Kirkpatrick, vice-Pres. of McGraw-Hill, toastmaster; John F. Collyer '17, Chairman of the Cornell Bd. of Trustees; Dean S. C. Hollister. Front Row; Charles H. Lechthaler '38, Alumni representative; Professor Rhodes; and Herbert F. Johnson '22, president of Johnson's Wax Co. and a Cornell Trustee.

COLLEGE NEWS

(Continued from Page 63)

major interest was, "Can electronic distance measuring replace triangulation and the tape?"

MORSE CHAIN COMPANY JOINS LOCAL CORNELL ASSOCIATES

The Cornell Associates, established in 1953, is aimed at advancing the natural partnership which exists between colleges and universities on the one hand, and business and industry on the other. Morse Chain has become the 143rd member of the Cornell Associates.

Robert O. Bass, executive vice president of the Morse Chain Company, and Marion P. Balliere, Jr., Cornell '38, treasurer and controller, represented the company at a meeting in the President's office.

"We are interested in promoting closer ties between our company and Cornell," Bass said.

President Malott, in welcoming Ithaca's Industrial Good Neighbor into the organization, said, "Support from industrial firms such as Morse Chain is becoming increasingly important to Cornell if we are to maintain the high level of our teaching and research. In return, the University offers valuable technical and research information to its Associates."

Other local members of Cornell University Associates are: The National Cash Register Company, the New York State Electric and Gas Company and Therm-Electric Meters Company, Inc.

PRATT & WHITNEY DISPLAYS TURBOJET ON CORNELL QUAD

Pratt and Whitney division of United Aircraft Corporation recently held a display of its jet engines on the Cornell Campus. The display, lasting from October 15th to the 16th, is part of its public relations program to familiarize undergraduate engineers with the activities at P&W.

The display consisted of a model of the Andrew Wilgoos Gas Turbine Laboratory, a J-57 turbojet engine and numerous photographs of engineering work related to jet engine design.

The J-57, which is used widely in today's jet aircraft, was designed and engineered at the Wilgoos Turbine Laboratory by P&W.

Recordings and color photos depicted the features of the engine which was cut away to show its internal mechanisms.

Other photos demonstrated problems encountered in airplane engine development. One picture showed the effects of radiation on grease. Because grease breaks down when exposed to radiation, a substitute would have to be found for nuclear powered ships.

The display will be at various other Eastern colleges throughout the winter.

TAU BETA PI HONORARY ELECTS FALL MEMBERSHIP

Tau Beta Pi, the national engineering honorary, elected the following students to membership this fall term:

Richard Grossgold	Arch	'58
Richard Owen Abbott	Arch	'58
Robert Lawrence Seidel	ChE	'58
Robert G. Spicher	CE	'58
Gordon Loren Kraus	CE	'58
Phillip Hall Kneen	CE	'58
Walter Richard Curtice	EE	'58
James J. Whalen	EE	'58
Peter Henry Wolf	EE	'58
William Carl Krell	EE	'58
Allan Shale Krass	EP	'58
Peter Crimi	ME	'58
Richard Spehalski	ME	'58
William H. Seymour	ME	'58
Bernard J. Snyder	ME	'58
Walter D. Gundel	ME	'58
HONOR JUNIORS:		
Michael Midler, Jr.	ChE	'59
Robert Edward Lee Turner	EP	'59
Herbert Peter Hess	ME	'59

COAL DERIVATIVES EXPERT SPEAKS ON ENG. MANAGEMENT

Joseph Pursglove, Jr., Cornell Class of 1930, vice president of research and development for the Pittsburgh Consolidation Coal Company, was the first guest lecturer before Fifth Year mechanical and electrical engineering students at Cornell University on Friday, October 11.

Mr. Pursglove spoke on "Engineering and Management Opportunities in the Coal and Coal Products Industries." He is an authority on the chemical products derived from coal and heads a staff of 150 researchers in the Pittsburgh firm. He is a member of the American Institute of Chemical Engineering, the Engineering Society of Western Pennsylvania, and the American Institute of Mining and Metallurgical Engineers.

The lecture series is designed to stimulate engineering students to think not only about their future professional careers but also about their roles as citizens. Lectures are given Friday noon in Room 101, Phillips Hall.

INDIA'S TECHNOLOGY STATUS DISCUSSED BY PROF. MALTI

At 8:00 P.M. on November 14, Professor Michael Malti, lately returned from a two year leave of absence in India where he helped organize an Electrical Engineering school, gave a talk in Phillips 101 before the members of the A.I.E.E. &I.R.E.

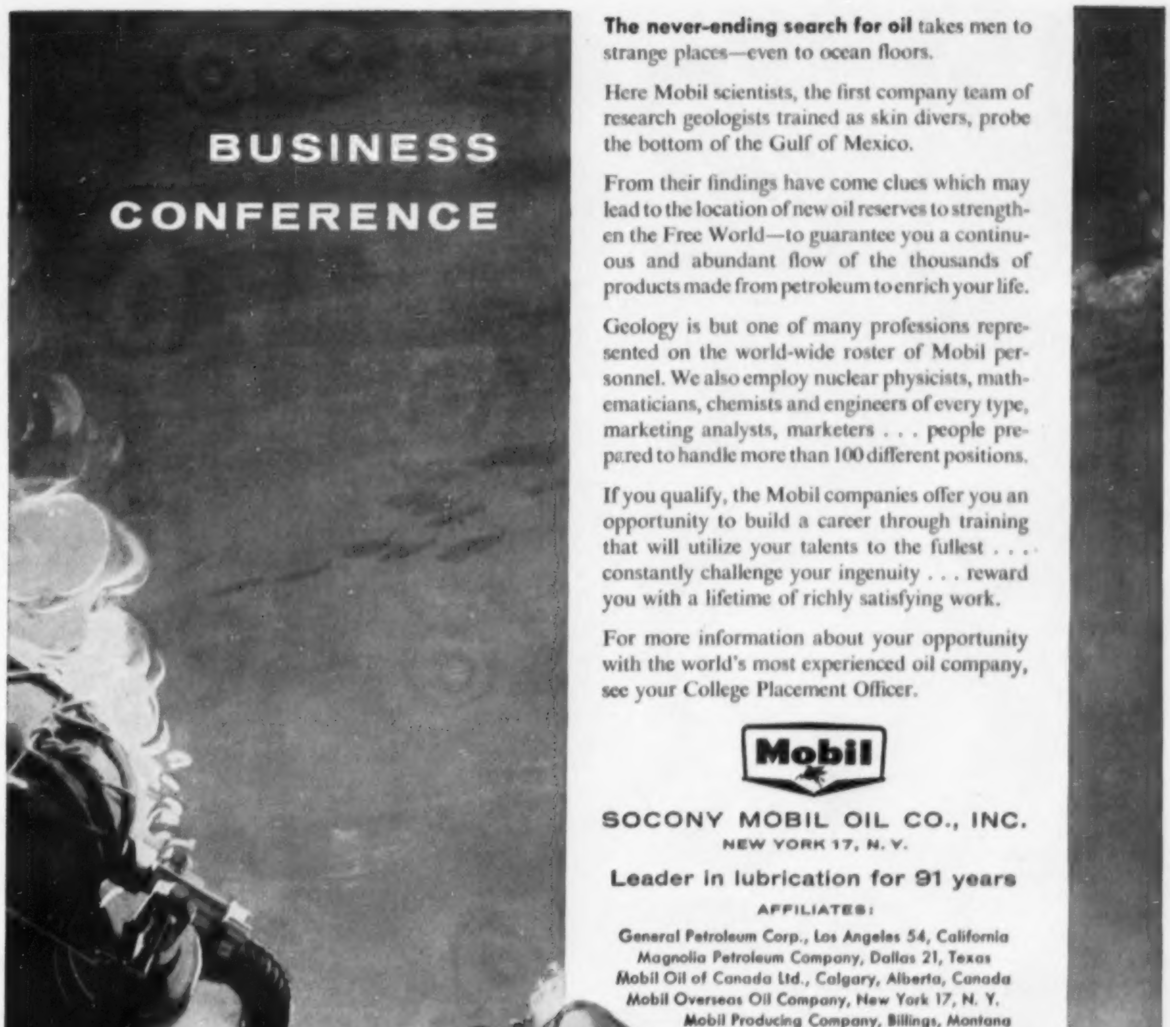
The talk emphasized the technical aspects of his work and the problems confronting India as she attempts to become a modern nation.

A reception was held after the talk at which Professor Malti answered general questions on his work.

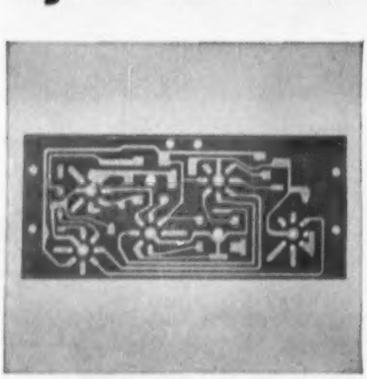
Although there were only a few members present, the officers of the A.I.E.E.&I.R.E. hope that speakers of Professor Malti's stature will encourage greater attendance at future functions.

CIVIL ENGS. SEE AIRCRAFT STRUCTURES AT GRUMMAN

On November 12th, those members of the Civil Engineering School interested in aircraft structural engineering were taken on a tour of the Grumman Aircraft plants at Bethpage, L. I. and Tunkhannock, Pa. The trip was arranged by Dr. Warner Lansing of the Grumman Corp., who received his Ph.D. at Cornell, and Professor George Winter, Head of the Structural Engineering Department, of the C. E. School. The tours concentrated on various phases of aircraft structural methods. Transportation was by Mohawk Airlines. The students arrived at Bethpage in the morning, flew to Tunkhannock in the afternoon, and returned to Ithaca by evening.


BUSINESS
CONFERENCE
The never-ending search for oil takes men to strange places—even to ocean floors.
Here Mobil scientists, the first company team of research geologists trained as skin divers, probe the bottom of the Gulf of Mexico.
From their findings have come clues which may lead to the location of new oil reserves to strengthen the Free World—to guarantee you a continuous and abundant flow of the thousands of products made from petroleum to enrich your life.
Geology is but one of many professions represented on the world-wide roster of Mobil personnel. We also employ nuclear physicists, mathematicians, chemists and engineers of every type, marketing analysts, marketers . . . people prepared to handle more than 100 different positions.
If you qualify, the Mobil companies offer you an opportunity to build a career through training that will utilize your talents to the fullest . . . constantly challenge your ingenuity . . . reward you with a lifetime of richly satisfying work.
For more information about your opportunity with the world's most experienced oil company, see your College Placement Officer.
Mobil
SOCONY MOBIL OIL CO., INC.
NEW YORK 17, N. Y.
Leader in lubrication for 91 years
AFFILIATES:
General Petroleum Corp., Los Angeles 54, California
Magnolia Petroleum Company, Dallas 21, Texas
Mobil Oil of Canada Ltd., Calgary, Alberta, Canada
Mobil Overseas Oil Company, New York 17, N. Y.
Mobil Producing Company, Billings, Montana
Socony Mobil Oil Company de Venezuela
and other foreign producing companies

Synthane laminated plastics report for work



Printed circuit for popular television receiver uses a metal-clad Synthane Laminate. Such a circuit eliminates wiring, wiring errors, saves space and weight.

Since the time when the heart of radio was the crystal and cat's whisker, Synthane laminated plastics have been the recommended insulation in the vital and ever expanding communications industry.

Turn on your TV or radio and Synthane goes to work as insulation in coil forms, transformers, tuners, plug-ins, switches, potentiometers, or as the metal-clad base for the entire printed circuit. Synthane also qualifies for important work in radar, sonar and guided missile applications.

Among the varieties of Synthane laminated plastics are several with insulation resistance and dissipation factor capable of controlling TV's high frequencies—even under tropically humid conditions. But Synthane makes over 30 grades—each with its own proportion of useful mechanical, electrical and chemical virtues. You can buy Synthane laminated plastics in sheet, rod and tube form or avail yourself of our complete fabrication service.

We have a number of interesting and informative folders on Synthane properties and applications. A post card will bring them to you promptly. Synthane Corporation, 13 River Road, Oaks, Pa.

COMPRESSIVE STRENGTH

DIELECTRIC STRENGTH

LIGHT WEIGHT

WEAR RESISTANCE

SYNTHANE S ...industry's unseen essential

SYNTHANE CORPORATION, 13 RIVER ROAD, OAKS, PA.

PROF. B. K. NORTHROP

Photo Science

Professor B. K. Northrop

The untimely death of Professor B. K. Northrop on Friday, October 25, 1957, shocked not only associates and students in the College of Electrical Engineering, but also many friends throughout the campus and community. He was 64 years old.

Except for seven years at Colgate, Professor Northrop has been connected with electrical engineering at Cornell since 1918 when he received his Bachelor of Mechanical Engineering in E.E. At this time electrical engineering was not established as a separate college of the university.

Through the years he has had several offers from industry, but his main interest has always been in teaching and working with students. While still a senior in mechanical engineering, he instructed an E.E. lab for juniors. During 1917 and 1918 he was also an instructor in the Cornell physics department. Then he progressed from an E.E. instructor in the fall of 1918 to assistant professor, to associate professor, and finally to full professor of electrical engineering in 1946. During the war he taught and supervised radio and electronics for the Engineering Science and Management War Training program.

For the past eight years B. K. Northrop has devoted most of his time to advising the freshman class of electrical engineers. It is in this capacity that he has exerted the greatest influence on so many students. To most of the freshmen he was not only their adviser, but also their first friend on the faculty; and for many, he was their best friend through all five years.

Few students will forget this balding man with a well trimmed mustache, who would straighten up in his chair and momentarily lay aside his cigar to give a smiling greeting to anyone entering his door. When he wasn't busy with freshmen, upperclassmen passing his office would say, "Hello, B.K.," and stop in for an informal chat.

The frosh would seldom hesitate to take their problems to "B.K." for he encouraged them to talk out their troubles with him. He also encouraged students to bring their parents along for discussion of major problems. Professor Northrop patiently and sincerely treated each boy's difficulties as an individual problem, often checking with the boy's instructors to seek out the root of his troubles. He keenly followed the progress of all "his boys" through their succeeding years at Cornell.

In addition to being class adviser and teaching, he was admissions officer for the College of Electrical Engineering and was a member of the university committee on student conduct. Until recently, he was also a counselor at frosh camp.

Professor Northrop developed the industrial electronics program at Cornell and did important consulting work for several industrial firms. He also had many articles printed in scientific publications.

He was a member of the American Institute of Electrical Engineers and was past president of the Ithaca branch. He was also a member of the Institute of Radio Engineers, American Society of Engineering Education, Acacia social fraternity, Eta Kappa Nu honorary fraternity for electrical engineers, the Ithaca division of the U.S. Power Squadron, and the Coast Guard Auxiliary. In addition, he was a member and past president of the Blue Lodge, F&L Masons of Hamilton.

Professor Casper L. Cottrell, who has been appointed new freshman class adviser and officer of the admissions board, sums up the feelings of the faculty and students in the following way: "B.K.'s passing is deeply felt by all who knew him. The gap he's left in the department will be difficult to fill, and his influence in the college and on the students will never be forgotten."

—Ronald F. Tesarik, EE '60

SILICON SOLAR CELL

(Continued from Page 37)

silicon solar cell. At present, the previously described set up of 432 cells is being tested at Americus, Georgia, where it is powering an all transistor carrier amplifier. The 432 solar cells are connected as a trickle charger for a 22½ volt nickel-cadmium storage battery. With this arrangement, power is available to the amplifier, day and night, bad weather and good. A portable FM transistor transmitter powered by solar cells has also been devised. It has been tested over short distances on the grounds of the laboratories at Murray Hill, N.J. It is thought that with suitable antennas the range of transmission could have been extended to several miles.

As far as the future is concerned, it is unlikely that the electric power companies will have much competition from solar cells. In order for one homeowner to use solar cells for his house, he would have to purchase a ton of storage batteries in order to insure power at night and in bad weather. The cost of the storage batteries alone would be $5,000.00 initially and $1,000.00 per year for maintenance.

It seems now that the most likely field for the solar cell to enter is communications. Particularly in telephone work, dependable, continuous duty, low capacity power supplies are needed in inaccessible locations (inaccessible, that is, to everything but telephone cables and sunlight). The combination of solar cell and storage battery is very well suited to such applications. Portable radios for use on beaches may also be powered by solar cells. Although it is still in the laboratory stage, it is certain that as the silicon solar cell's development continues, many new uses for its energy conversion characteristics will be found.

BIBLIOGRAPHY (Silicon Solar Cell)

1. *Electricity from the Sun*, G. L. Pearson, Proceedings of the World Symposium on Applied Solar Energy, pp. 281-288, April 1956 Bell Monograph 2658
2. *The Bell Solar Battery*, D. M. Chapin, C. S. Fuller, & G. L. Pearson, Bell Laboratories Record, v. 33 #7 pp. 241-246, July 1955
3. *Silicon solar energy converters*, M. B. Prince, Journal of Applied Physics, v. 26 #5 pp. 534-540, May 1955
4. *An Appraisal of Silicon and its Alloys*, Metal Progress, v. 63 #2 pp. 105-109, Feb. 1953 also Air Force Technical Report 6383
5. *Diffusion of Boron and Phosphorous into Silicon*, C. S. Fuller, J. A. Ditzenberger, Journal of Applied Physics, v. 25 #11 pp. 1439-1440, Nov. 1954
6. *Diffusion of Donor and Acceptor Elements in Silicon*, C. S. Fuller, J. A. Ditzenberger, Journal of Applied Physics, v. 27 #5 pp. 544-553, May 1956
7. *The Solar Battery*, Gordon Raisbeck, Scientific American, v. 193 #6 pp. 102-110, Dec. 1955
8. *Growth of Germanium Single Crystals containing* p-n *Junctions*, G. K. Teal, M. Sparks, E. Buehler, Physical Review, v. 81 #4 p. 637, Feb. 15, 1951
9. *Preparation of Hyper-pure Silicon*, D. W. Lyon, C. M. Olson, E. D. Lewis, Journal of the Electrochemical Society, v. 96 #6 pp. 359-363, Dec. 1949
10. *Principles of Transistor Circuits*, R. F. Shea, New York, 1953
11. *Solar Battery Uses Plastics*. Modern Plastics, v. 33 #6 p. 104, Feb. 1956

CORRECTION TO OCTOBER ISSUE

The following example appeared in the October issue of THE CORNELL ENGINEER in the article "The Development of Numerical Notation" by Peter H. Jedel:

$$\begin{array}{r} 3'\ 4'' \\ \times \quad 4'\ 6'' \\ \hline 1'\ 8''\ 0'' \\ 13'\ 4'' \\ \hline 15' \end{array}$$

The answer should have been corrected to read 13′ in the duodecimal system which is the decimal equivalent of 15′.

A Vought Vignette
ONE OF A SERIES

Why the Missile Engineer Never Missed Mail Call

Vought's Regulus II missile took shape just a short walk from the desks of its developers. Engineers handled the new hardware and monitored tests in person — literally flying the big missile on the ground at Dallas. It was a convenient arrangement while it lasted.

Then a big USAF Globemaster landed and taxied to Vought's Experimental Hangar. The missile was winched aboard and airlifted to a desert site for flight tests. By nightfall there was a 1,000-mile rift between Regulus II and home base.

Joe Boston was ready to step into this gap. As Project Assistant for Field Liaison, he'd already equipped Vought's desert crew for extensive flight tests. Now he'd make sure that test data and hardware flowed uninterrupted from the desert to Vought. High-speed feedback of facts on one flight could influence the success of the next.

Mail from the desert poured in to Joe at Vought. From project men at the flight test site came parts for immediate rework and return. From the flight test crew's mobile ground station came rolls of telemetered brush records. From the recoverable Regulus itself, came packets of oscillograph data. And from Field Service — for repair or replacement — an occasional wrench or relay.

Joe served as clearing house and consultant. Flight data was reduced and released to design and support groups. It revealed not only missile performance, but the temperatures and pressures of a strange new environment. When data pointed toward design changes, Joe's time and cost estimates helped specialists reach decisions.

Thanks to Vought's fast overland relay of hardware and data, the records of one flight were decoded and digested in time to improve the next hop. Dividends in performance and reliability were obvious after six flights had been logged by Regulus II.

All six had been flown by one vehicle.

Chance Vought uses comprehensive testing and data analysis to assist the engineer through unexplored problem areas. Test facilities strengthen every phase of the development cycle, and procedures are aimed at feeding data quickly into the engineering process.

BUILDERS OF MILITARY AIRCRAFT
40th ANNIVERSARY
1917 TO 1957

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

Research at Cornell—

RADIO STAR WAVES PROBE ATMOSPHERE

Properties of the earth's ionosphere and troposphere can be deduced from the refraction of radio-frequency energy passing through the earth's atmosphere. A study of atmospheric refraction of radio waves from radio stars is now being made at Cornell for the U.S. Air Force by Professor Joseph L. Rosson of the Department of Electrical Engineering.

Cassiopeia-A, which is located in the constellation Cassiopeia about 30° from Polaris (the North Star), is a radio star that emits radio waves of many different wave lengths. Due to refraction, radio waves from Cassiopeia-A that enter the earth's ionosphere experience bending and changes in direction of polarization which give an apparent position of the star which is different from the position obtained by direct visual astronomy. Knowing this difference it is possible to measure phase changes in the arrival of the signal due to the refraction of the radio waves. Changes in signal strength due to dynamic changes in the structure of the ionosphere are also measured. The apparent changes in angular refraction are known as *phase scintillations* and changes in signal strength as *amplitude scintillations*, analogous to the dancing and twinkling of visible stars.

The technique of measuring the apparent position of the radio source involves the use of an interferometer which measures the interference between the signals from two antennas placed on a base line of accurately known direction and antenna separation. A special receiver is used to detect the information and feed it to recording instruments. Information on refraction in both the horizontal and vertical directions is desired and for these purposes an interferometer is oriented in an east-west direction and another in a north-south direction. The location of the field site itself is immediately north of the present Radio Astronomy Laboratory located near the Cornell University airport.

The application of the traveling-wave antenna is a unique and novel idea conceived by Dr. Henry G. Booker of Cornell. The antenna is designed so that the radio source Cassiopeia-A is always kept on the main beam of the antenna throughout the solar day, while, at the same time, the undesirable radio signal from the radio star Cygnus falls into a minimum of the antenna's radiation pattern. This means that it is possible to follow the radio movement of the source using interferometry without continuously tracking it. Also, incident radio-frequency energy from sources other than Cassiopeia is minimized.

Data obtained from this project will not only aid a great deal in the study of the structure and of some of the properties of the ionosphere and troposphere, but will also advance knowledge on new kinds of radio transmission. Much of the theory for this work was developed by Dr. Booker and the experiment described here was first proposed by Dr. Benjamin Nichols.

Warren L. Levy
E.E. '59

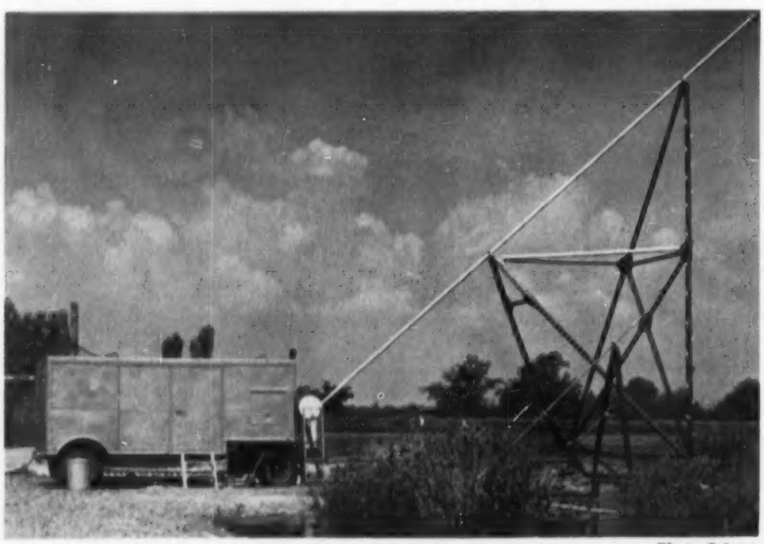


Photo Science

Traveling Wave Antenna used in research on atmospheric refraction.

RADIATION COUNTER

(Continued from page 30)

small voltage rise almost instantaneously when a ray strikes the crystal.

The current produced at the anode of the photomultiplier does not always vary directly with the rays hitting the crystal. The radioactive particles hitting the crystal may have different energy levels. Also, depending upon the angle of which the particles enter the crystal, differing amounts of energy will be dissipated. Because the particles lose varying amounts of energy, the intensity of light given off will also vary. Thus, when necessary, the readings must be compensated for by correction curves.

Other Detection Methods

There are still a few other methods employed in detecting radiation, but the two previously explained are the most common. Now the problem remains to convert the electrical impulses produced by the detector into some sort of reading or measurement. The two most widely used devices are a scaler, which counts each individual pulse, and a ratemeter, which integrates the pulses and gives a direct reading on a meter. Both of these methods provide the vital information to further our knowledge of radioactivity as well as to insure the safety of workers in contaminated areas.

Source: Anton Electronics Laboratory, Inc., Brooklyn, N.Y.

For Sikorsky's new 18-acre plant . . .

Architects and Engineers: F. A. FAIRBROTHER AND GEORGE H. MIEHLE, Detroit; with ALBERT KAHN ASSOCIATED ARCHITECTS AND ENGINEERS, Detroit, as consultants.

General Contractor: E. & F. CONSTRUCTION CO., Bridgeport.

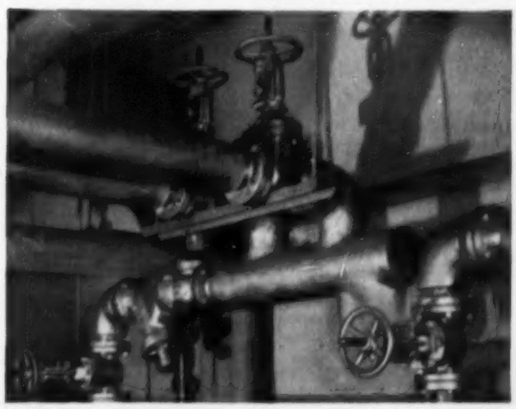
Mechanical Contractor: JOHN WINKLE, INC., Larchmont, N. Y.

Where reliability is the watchword **JENKINS VALVES** were selected

Reliability has characterized Sikorsky Helicopters throughout a long record of military and commercial service. A watchword in the building of these versatile airplanes, *reliability* also was made the critical measure of all equipment for the 18-acre Sikorsky plant recently completed in Stratford, Conn.

On the valves to control much of the complex network of pipelines, management, architects, engineers and contractors found it easy to agree. From long experience on many jobs all could be sure of the reliability of Jenkins Valves.

This confidence in the specification "JENKINS", has been shared by building experts and plant operating men alike for 93 years. The valves that have won this great confidence bear the Jenkins Diamond trademark . . . and *they cost no more*. Jenkins Bros., 100 Park Ave., New York 17.



JENKINS VALVES shown controlling heating lines. Used throughout the Sikorsky plant on steam, water, air and process piping.

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
SINCE 1864

Sold Through Plumbing-Heating and Industrial Distributors

SCOTTISH LABOR

(Continued from Page 27)

He takes it out of the pack and gives it to his companion. In larger matters, the Scotsman's small wage forces him to seek value for his money. Food, clothing, and lodging are inexpensive by U.S. standards. Large luxuries such as automobiles and television sets cost more than they do in the U.S. Therefore, a worker whose wage is as good as an American worker's wage in terms of necessities is forced into a somewhat lower standard of living.

Tradesmen's pay does not usually increase with seniority. This, and the high taxes tend to keep the men in the same economic bracket for their whole lives. Many live for the day when they can hit the jackpot. Government-controlled radio eliminates the giveaway programs, yet dozens of other get-rich-quick schemes tantalize the skilled workers.

Huge sums are bet on the horse races. The tracks and the bookie agencies—which advertise in the newspapers—are readily available. Private bookies—all illegal entrepreneurs—abound. Some factory hands regularly meet the bookie at lunchtime to place their money on that afternoon's races.

Hundreds of tradesmen earn welcome additions to their incomes by running within-the-works lotteries.

Nationwide football pools whose advertisements describe how 2d can win £75000 are very popular. The Aberdeen post office has four mail slots: "local," "inland," "abroad" and "football pools."

Even the government takes advantage of the gold fever. Sales of interest bearing bonds are quite low among a skilled laboring class which has virtually no investments other than pension funds and which keeps its life insurance to £10-£20, just enough to cover the cost of dying. There has been a successful sale of bonds which bear no interest but which entitle the owner to a chance in a lottery.

Scottish tradesmen lead a comfortable, very secure life. Their government and union pension, health, etc., systems guarantee their financial well-being. These tradesmen do not enjoy the same standard of living as their counterparts in some other nations; partly because of Britain's straitened economic situation, and partly because of a lower productivity. The workers try to raise themselves by winning large sums or, more successfully, by raising the occupational level of their children. It is this, combined with very large government subsidies for some students which now allows reasonable numbers of tradesmen's sons to enter college.

A highly democratic society, where even the cultural institutions such as the British Museum cater to the interests of the tradesmen, and an intense patriotism are helping Scottish labor to push Britain to greater prosperity than was known when the empire was at its height.

Albert Sacerdote, a fifth-year student in the School of Chemical Engineering, lived in Europe until May 1940. Since then he returned three times. Two of these trips were made to the Continent; however, last summer the author worked in Scotland as a student trainee of a Scottish firm. It is upon his experiences last summer that this article is based.

ALUMNI ENGINEERS

(Continued from Page 49)

Stanley W. Zimmerman, professor in charge of Cornell's High Voltage Research Laboratory, served as secretary-treasurer at a three-day conference of the Academy of Sciences of the National Research Council on October 21-23.

Professor Zimmerman led a round-table discussion on high voltage cable developments and took part in a discussion on insulation design. He is also a member of the committee publishing the annual digest of literature on dielectric phenomenon.

The conference was attended by 300 scientists, including chemists, physicists, engineers and others interested in the research, development and application of electrical insulating materials.

Eugene W. Kettering '30, has received one of three Elmer A. Sperry Awards for 1957. The awards are given in recognition of a distinguished contribution to the art of transportation.

Mr. Kettering participated in the development of the original General Motors Diesel engine and was project engineer in charge of the development of the 567 series engine, which became the "railroad" engine. He is at present head of the research department of the Electro-Motive division of General Motors.

The Sperry Award commemorates the life and achievements of Dr. Elmer A. Sperry (1860-1930) whose inventiveness contributed directly and indirectly to improvements in transportation by land, sea and air. The award was established in 1955 by Dr. Sperry's daughter, Mrs. Robert Brooke Lea, and his son, Elmer A. Sperry, Jr. (Cornell 1917), and is presented annually.

Mr. Kettering lives in Hinsdale, Illinois.

Mr. Lea, Dr. Sperry's son-in-law, is a member of Cornell Class of 1915.

George H. Barnard, BSAE '49, joined Knolls Atomic Power Laboratory in 1952, presently KAPL Senior Resident Engineer at the Material Testing Reactor, Arco, Idaho.

Donald H. McClelland, MAreoE, has joined the Guided Missile Research Division, The Ramo-Wooldridge Corporation, Los Angeles.

Mr. McClelland's experience includes aerodynamics, flight dynamics, flutter and gust loads analysis, gas dynamics, heat transfer acoustics, and rocket propulsion system analysis.

He received his A.B. degree in physics at the University of Kansas and his masters degree in aeronautical engineering at Cornell University. He is a member of Phi Beta Kappa, Sigma Pi Sigma, Delta Phi Alpha. He is affiliated with the Institute of the Aeronautical Sciences and the American Rocket Society.

Mr. McClelland resides at 4190 Somerset Drive, Los Angeles, Calif.

Robert L. Gifford, CE, '90, '91, retired engineer who lives at 1231 South El Molino Avenue, Pasadena 5, Cal., has returned from a flight to Honolulu, Manila, Bangkok, Ankhor Wat, Hong Kong, and Japan. It was his third trip to Honolulu this year. Gifford is a member of the Royal Horticultural Society, London, and a life member of the Honolulu Orchid Society.

R. A. Woodle, BChemE, Supervisor of Lubricants Research at The Texas Company's Port Arthur-Port Neches, Texas, Research Laboratories, is the co-author of a technical paper, "Electrolysis of Used Refinery Caustic through a Cation Permeable Membrane," which he will present before the Southwest Region of the American Chemical Society at a meeting in Tulsa, Oklahoma, on December 5, 6 and 7.

Mr. Woodle joined Texaco in 1944 after receiving his Bachelor of Chemical Engineering degree. He was assigned to the Port Arthur Research Laboratories and has held a succession of assignments and is now Supervisor of Lubricants Research.

Mr. Woodle is the author of several technical papers presented before various professional societies during his career with Texaco. He is a member of the American Chemical Society.

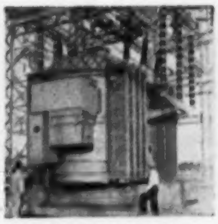
ALLIS-CHALMERS

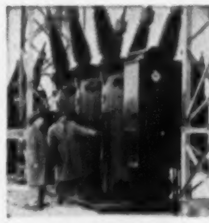
...where you can design, build, research or sell products like these

...and grow with 3 growth industries

POWER EQUIPMENT


Steam Turbines


Transformers of all Types


Circuit Breakers

CONSTRUCTION


Road Building Equipment


Pumps, Blowers


Cement-Making Equipment

MANUFACTURING


Motors


Control


V-Belt Drives

Opportunities in these fields

Thermodynamics
Acoustics
System Analysis (Electrical and Mechanical)
Stress Analysis
Hydraulics
Electronics
Process Engineering
Mechanical Design
Structural Design
Metallurgy
Nucleonics
High Voltage Phenomenon
Analog and Digital Computers
Fluid Dynamics
Basic Research

You can grow faster in a company that supplies the basic needs of growth! Power, construction and manufacturing *must* grow to supply the needs of our population which is increasing at the rate of 50,000 per week. Allis-Chalmers is a major supplier of equipment in these basic industries.

But there's another factor of equal importance: Allis-Chalmers Graduate Training Course offers unusual opportunities for the young engineer to:

- Find the type of work he likes best
- Develop engineering skill
- Choose from a wide range of career possibilities

Allis-Chalmers graduate training course has been a model for industry since 1904. You have access to many fields of engineering: electric power, hydraulics, atomic energy, ore processing.

There are many *kinds* of work to try: design engineering, application, research, manufacturing, sales. Over 90 training stations are available, with expert guidance when you want it. Your future is as big as your ability can make it.

Or, if you have decided your field of interest and are well qualified, opportunities exist for direct assignments on our engineering staff.

In any case—learn more about Allis-Chalmers. Ask the A-C manager in your territory, or write Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS A-C ALLIS-CHALMERS

5196

STRESS *and* STRAIN...

"I'm losing my punch," she said, as she left the cocktail party in a hurry.

• • •

"How'd you puncture your tire?"
"Ran over a bottle of milk."
"Didn't see it, huh?"
"Naw, the kid had it under his coat."

• • •

"The editor just hanged himself."
"Have they cut him down?"
"Not yet. He isn't dead."

• • •

A flight of bombers had ranged far and wide over Germany, spreading tons of propaganda leaflets over the Third Reich.

All planes returned safely to their base except one. Hours passed. Night fell. Still no plane. Finally, its engines were heard. As it landed, the operations officer ran out to the plane. "Where have you been anyway?" he yelled.

"I delivered the leaflets, that's all," was the reply.

"How long does it take you to drop leaflets?"

"Drop 'em?" said the pilot. "We were pushing 'em under people's doors."

• • •

The height of bad luck—seasickness and lockjaw.

• • •

The ocean was rough. As the steward was taking a bowl of soup to a stateroom he lost his balance on the uncertain deck and poured the contents into the lap of an old gentleman asleep in a deck chair. Keeping his wits, the steward tapped the old gentleman on the shoulder and asked solicitously, "I do hope you feel better now sir."

• • •

A ChE was experimenting with new formulas for beer. He labored on his various theories for over a year, and when finally hitting upon what he thought was a revolutionary process, he sent the formula to a laboratory to be analyzed.

The reply came back, "Your horse has diabetes."

He. "I'm groping for words."
She: "Well, I hope you don't expect to find them there."

• • •

Jane: "Why doesn't John ever take you out to the movies anymore?"
Joan: "One evening it rained and we stayed home."

• • •

"What kind of guy is your roommate?"

"Well, last night he stubbed his toe on a chair and said, "Oh, the perversity of inanimate objects."

• • •

An Air Force man from Kentucky volunteered: "It's kinda hard to be polite to a Northern girl. Before Ah can open a door for her, she has opened it, gone through it and sla-ammed it in mah face!"

• • •

Situation: Two infants in the nursery of the maternity ward of a hospital.
First Infant: "I'm a little boy."
Second Infant: "How can you tell?"
First: "Wait till the nurse leaves and I'll show you.
The nurse left and the first infant pulled down the covers and said, "See, blue booties."

• • •

A pink elephant, a green rat, and a yellow snake walked into a cocktail bar.

"You're a little early, boys," said the bartender. "He isn't here yet."

• • •

After watching a drunk try to unlock the door to his house without success, a policeman went over and asked if he might handle the key for him.

"No thaksh," the inebriated chap answered. "I gotta pretty good hold on thish key. You try and grab the housh."

• • •

Engineer: "Going around with women a lot keeps you young."
Second Engineer: "How come?"
Engineer: "I started going around with women when I was a freshman two years ago, and I'm still a freshman."

M.E.: "Got a match, Jack?"
E.E.: "Here it is."
M.E.: "Well, how about that? I've forgotten my cigarettes."
E.E.: "Too bad. Give me back my match."

• • •

And then there was the rather forlorn engineer who, on seeing a pigeon flying overhead, exclaimed: "Go ahead, everybody else does!"

• • •

"Wanna see two cute devils?"
"Sure."
"Well, go to hell."

• • •

If it's funny enough to tell, it's been told; if it hasn't been told it's too clean; and if it's dirty enough to interest an engineer the editor gets kicked out of school.

• • •

A castaway on a desert island, following another shipwreck, pulled ashore a girl clinging to a barrel.

"How long have you been here?" asked the girl.

"Thirteen years," replied the castaway.

"All alone—then you're going to have something you haven't had for thirteen years," said the girl.

"You don't mean to tell me that barrel is full of beer."

• • •

Overjoyed at the news that he was the father of triplets, an excited father rushed down to the hospital and without waiting for any ceremony dashed pellmell into the delivery room.

"Wait a minute, sir" the shocked nurse shouted at him. "You can't go in there now, with your clothes full of germs! You're not sterile!"

"You're telling me!" shouted the father.

• • •

"I'll bet you wouldn't marry me," he said.
She called his bet and raised him five.

• • •

Guest to the host in new house: "Hello, Bud, how do you find it here?"
Host: "Just walk upstairs and then two doors to the left."